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DO WE LIVE IN A SPIRAL NEBULA?[1]

In May, 1925, my colleague, Dr. Joseph H. Moore, and I determined anew the elements of the motion of the solar system, upon the basis of the radial velocities of 2,034 stars, as observed at the Lick Observatory and at the Chile Station of the Lick Observatory. The apparent solar motion was found to be toward a point in the heavens having right ascensions 268°.9 and declination +27°.2, with speed 19.0 km per second. These results are in good agreement with those obtained by me from 1,193 observed radial velocities, in 1911, as follows: right ascension 268°.5, declination +25°.1, and speed 19.5 km per second.

The direction in which we found the solar system to be moving makes an angle of 22° with the plane of the Milky Way. Moving with a speed of 19 km per second, the solar system travels 600,000,000 km per year, or four times the mean distance of the earth from the sun. We are doubtless showing high respect for the values of understatement when we say that our sun is at least many hundreds of millions of years in age. Clearly our solar system in its early youth did not have its present position in the stellar system, and its old age will find it in still other surroundings. We can not speak with confidence concerning the path upon which we are traveling, whether it is a great closed curve—an elongated ellipse, for example—which will suggest our return a few hundred millions of years hence to our present point of observation, or whether it is a path so curved that it does not return unto itself. If the stars were distributed in a system having spherical symmetry the center of the system should be the effective center of gravitational attraction and, neglecting minor perturbations, our sun should describe an ellipse about that center. But we know that our stellar system is not spherical either as to form, or as to the grouping of its component stars, and therefore the path followed by our sun probably differs somewhat from an ellipse. It is of interest to note that if our stellar system were spherical in form and the stellar materials were uniformly distributed through it, the revolutionary periods of the individual stars would all be equal, no matter what their distances from the center, no matter what their observed speeds at any instant, might be. A knowledge of the density of distribution of the star materials would at once tell us the com-

[1] Address of the retiring president of the American Astronomical Society, read at Rochester, New York, January 2, 1926.

mon period of revolution. Eddington has calculated that a density of distribution which assigns ten stars, each equal in mass to our sun, to every sphere of space 33 light years in diameter would mean a period of 300,000,000 years for the sun and all other stars around the center of mass of the system. But, let us repeat, our system is not spherical in form, nor as to its stellar distribution, and we do not know the density of mass distribution even in our own neighborhood.

But at this point many questions suggest themselves. We are constrained to ask: May not our stellar system be one of those mysterious objects which we call spiral nebulae? Easton of Belgium considered this subject seriously, and rather favorably, a generation ago. The memorable discussion of the probable dimensions of our stellar system, conducted by Curtis and Shapley in 1920, under the auspices of the National Academy of Sciences, bore here and there upon this question, as well as upon the related question, Are the spiral nebulae island universes? Aside from the studies mentioned, the subject of our stellar system as a spiral nebula has received only haphazard attention.

The spectrum of a typical spiral nebula closely resembles the spectrum of our sun; as if the spirals were great collections of suns. Some of the spirals are from their spectra observed to contain true nebulae, just as our stellar system has many nebulae distributed within it.

The spirals closely resemble our stellar system in general outline. Their major dimensions are many times as great as their thicknesses, ten times as great in some observed cases. From the days of Herschel's star counts—star gauges, he called them—we have known that our system is lenticular in form. Recent students of the subject incline strongly to the view that the ratio for our system is even much greater than 10 to 1.

Casual observation of spiral nebulae is sufficient to convince us that they are in rapid rotation—that is clearly the reason why they resemble lenses in form. The spectrograph has measured the rotational velocities of two or three spirals, with results about as might have been anticipated.[2] The observed rotational data, treated in accordance with the laws of celestial mechanics, tell us that these few spirals are each massive enough to supply materials for millions of stars equalling our sun in mass.

Hubble with the 100-inch reflector at Mount Wilson has recently resolved a few of the largest spirals into myriads of stars. He has shown that two of them—the two which have the largest angular diameters—are nearly a million light years[3] from us, and therefore that they have enormous linear dimensions. Expressed in light years their diameters are probably of the order of 40,000[3] in one case and 10,000 or 15,000 in the other.

When viewed edgewise, or nearly so, the spirals generally show the presence of absorbing or occulting matter on or near their peripheries. If we were near the center of one of the more or less irregular masses in one of the arms of a spiral, looking out through the supposedly starry heavens, might not the counts of stars show remarkable similarity to the star gauges of Herschel? Shouldn't we expect to observe a Milky Way? Would not such a Milky Way be irregular in outline and intensity, and show cloud forms? Might not absorbing or occulting matter in a spiral, apparently an attribute of many of them, produce a bifurcated structure, similar to that of our Milky Way as seen in the night sky of the northern summer? Might not the central thicker nucleus of the spiral be actually invisible, save as to its two outermost segments, just as in the double section of our Milky Way we may be seeing merely the outermost segments of its thickest part? Or, it may be that an observer in one of the distant spirals, by virtue of prevailing obstructions in his line of sight, would not see the spiral nucleus at all, as we may possibly, though not probably, be prevented from seeing the nucleus of our system. Astronomers know that the appearance of our Milky Way, as to its outlines and densities, is profoundly influenced by obstructing material which interferes with our view of it. The apparent division of our Milky Way structure at its widest parts is thought to be due to the presence of invisible obstructing materials, in vast quantities.

Curtis's Crossley-Reflector photographs of several dozens of spirals which are strongly inclined to the line of sight show what appear to be absorption or obstruction effects in essentially all cases. These effects in some spirals persist right up to the central nuclei: the halves of a few such nebulae, thought to be the halves nearest to us, are reduced in brightness, as if a considerable share of the radiations which would otherwise have come to us from those hemispheres were cut off by obstructing materials. If such an obstructing system, perhaps preferably an occulting system, prevails on and near the periphery of our stellar system, an occulting structure of considerable thickness existing not only in the plane of

[2] Considerable doubt seems to have existed, and possibly still exists, as to the proper assignments of the spectrographically observed rotational speeds to the apparently nearer or to the apparently farther edges of the spirals concerned.

[3] These distances and dimensions do not differ greatly from those arrived at several years ago, by Curtis and others, from the observed magnitudes of the novae discovered in the spirals.

the Milky Way but extending out at right angles to it considerably farther than the radiating stars extend—as seems to be the case in some of the oblique spirals referred to—then we should not be able to see faint objects, such as spiral nebulae, in the direction of the Milky Way, or on or near its borders. Now this is exactly in accord with the facts of observation. With the Crossley Reflector, Keeler showed that there are certainly many tens of thousands of nebulae in the heavens, which have the general form of spiral nebulae. Though Hubble's photographs with the 100-inch reflector of Mount Wilson have failed to show spiral structure in many of these nebulae, their spectra seem to resemble closely the spectra of spirals. They are extremely plentiful in a large region of the sky which contains the north pole of the Milky Way, that is, in the region farthest from the Milky Way, and they are plentiful in a very large region surrounding the south pole of the Milky Way; but as the sky areas photographed are closer and closer to the Milky Way, the numbers of spiral nebulae recorded grow smaller and smaller, and before the Milky Way structure is reached the spirals cease to show at all. In the direction of the Milky Way background, which covers a pretty large area of the sky, not a single spiral nebula has ever been observed.

Shapley's studies of the distances of many globular star clusters in the Milky Way, which are prevailing close to its central plane and may therefore be assumed to be component parts of our stellar system, have led him to the conclusion that even if the most distant clusters are on the actual periphery of the system the radius of our stellar system must be of the order of 150,000 light years.[4] The presumably nearest spiral nebulae are nearly a million light years away, and we have no apparent means of telling how far away are the ones with angular diameters so small that they are difficult to distinguish from single stars. Perhaps it is too much to expect that the greatest of the spirals should be our nearest neighbors; at any rate it is not difficult to imagine that some of the more distant spirals have linear diameters equaling or exceeding the diameter of our stellar system. Recalling, from the theological history of the world, that man always started out with the idea that his abode was the center of the universe, and later became more humble, it would be surprising if our stellar system should prove to be unique either in kind or in size. It would be astonishing indeed if our thin and flat stellar system had tens of thousands of spiral attendants to the right of it, and tens of thousands of spiral attendants to the left of it but none in front of it, none in or near any extension of its principal plane.

The motions of the spirals seem also to free them from the charge that they are retainers of our stellar system. Slipher has found them to have uniquely high radial velocities; from 300 km per sec. approach up to 1,800 km per sec. recession, for 43 observed nebulae not in our stellar system; 24 of them showing detailed spiral structure and the remaining 19 the general forms of spiral nebulae. Although other conditions than the radial velocity of the light source as a whole are known to displace spectral lines from their normal positions, there seems now to be no inclination to doubt that the large displacements observed by Slipher are chiefly and perhaps wholly Doppler-Fizeau effects.

Following the methods employed for determining the motions of the solar system from radial velocity data for the surrounding stars, Lundmark has determined the motion of the solar system with reference to the 43 spirals as a system. He obtained a velocity of 401 km per sec. Naturally the solution, depending upon very limited data, is of limited weight, but accepting the solution at its face value it says that with reference to the 43 spiral nebulae, considered as a system at rest, the sun and its group of neighboring stars comprising our naked-eye system, and perhaps representing fairly well our entire stellar system, is travelling with a speed of about 400 km per sec.—a speed of the same order of magnitude as the radial velocities possessed by many of the 43 spiral objects themselves. Even as to its speed our stellar system appears to conform to the spiral type. Should it appear in the sequel that the extremely distant spirals have actual radial velocities lower than those observed, because a curvature of space, conforming to the Einstein theory of relativity, would have the effect of adding to their apparent velocities of recession, the percentage of change required in the dimensions I have quoted should be low.

Referring to dynamical conditions within the spirals: why have they developed into their present state, and how do they maintain their strange forms in the face of strong central gravitational attraction? The comprehensive answer is, they are in rapid rotation. Jeans and others, making profound studies of these objects, have come to this conclusion. In fact, as noted above, one has but to look at the photographs of the brighter and larger spirals, including those viewed obliquely as well as those seen edgewise and in full face, to obtain the conviction that this is so.

[4] It is an interesting fact that whereas Shapley viewed with disfavor the island-universe interpretation of spiral nebulae, and Curtis was unable to accept Shapley's dimensions of our stellar system, Miss Leavitt's formula for the period-luminosity relationships in Cepheid variable stars, after modification of its constants by Shapley, was used by Hubble to establish the island-universe dimensions of the spiral nebulae.

The measures by van Maanen have appeared to show rapid motion outward along the spiral branches for the matter composing the branches. These van Maanen components of motion apparently include such other components as arise from the relatively rapid revolution of the several measured points around the centers of the spirals. But as my purpose is not to discuss the mechanics and dynamics of spirals, except in a most general and limited way, I do not attempt to interpret the measures made by van Maanen, in the light of apparently conflicting results obtained by Curtis, Ritchey, Lundmark, Hubble and others. My question is, assuming the composition of the spirals to be chiefly stellar, with each nuclear mass a group of stars widely separated, in what orbits do the individual stars move? Is it not possible that the stars in any one great group are not totally free to depart from their group, and are not free to describe elongated elliptic orbits around the center of mass of the spiral, except as fortuitous perturbations may free a star now and then from the serious and perhaps commanding influence of its group? The general form of orbit described by a star at a great distance from the center may resemble a circle, in response to the rotation of the entire spiral body; but it would be surprising if a great number of stars composing one of the nuclei in a spiral arm should not develop their own system of motions, in response to the conditions of equilibrium. If the principal dimensions of a spiral are a few tens of thousands of light years, the thickness of some of its more or less isolated masses may be several thousand light years, and the stars composing such a mass may well have their local system of orbital motions, very much as Jupiter and his three outermost moons have their local system of motions, though subject to large perturbations from the differential attractions of the sun, while revolving around the sun.

But to come back to our own system: How has it happened that our system, so enormous in its Milky Way dimensions, is relatively so thin and so flat? It is at least as thin, relatively, as any spiral thus far observed in an edgewise position. Must it not have developed with the accompaniment of high rotational speed? Or if formed, and in the absence of rotation, could its stellar cloud forms have avoided dissolving or collapsing? Answers in favor of a rotation of the system, now and throughout the history of its development, seem to me natural, and reasonable, and I am tempted to say necessary. We all incline to the opinion that the developments of the individual stars have covered several thousands of millions of years. For the Milky Way structure to form, to endure through long ages, and to present no recognizable signs of collapsing, it must be in a state of equilibrium; and equilibrium in such matters, to the best of our knowledge, means a rotation of the system around an axis through the effective center of mass of the system. For a system so vast as to its distances, and with so low a distribution of materials throughout its extent, an extremely slow speed of rotation would be called for: Poincare has estimated that an angular speed of a few tenths of a second of arc per century would suffice to maintain equilibrium. The observed proper motions of the stars have been utilized by half a dozen astronomers in efforts to uncover the first indications of a rotational effect. Out of eleven such results, six indicated rotation of the stellar system toward the east and five rotation toward the west, all being at exceedingly slow rates. We may therefore say that the evidence presented by them is negligible. Charlier has found that the line of intersection of the invariable plane of the solar system with the central plane of the Milky Way is apparently shifting easterly amongst the stars by 0.35 second of arc per century. A literal interpretation of this result favors a rotation of the Milky Way system westerly at the slow rate quoted. The subject is an extremely difficult one and the discovery is for the future to make.

We do not know, I must confess, that our stellar system is now a spiral nebula, or that it is the developed product of a spiral of ages past, but it does seem to have most of the known attributes of a spiral. The motions of our naked-eye stars are in such directions and of such speeds in general that their velocity components in the plane of the Milky Way are larger than their components at right angles to that plane, as perhaps we should expect, but the latter components are relatively much larger than we should expect, or have succeeded in explaining, on the supposition that we are dealing with motions in orbits which have the effective center of the great stellar system in or near their foci. There are many other perplexing facts brought to light when we attempt to determine the elements of the solar motion with reference to groups of stars having different spectral classes, or very different absolute magnitudes, or velocities of very different orders of magnitude. It is quite possible that the wide variety of results for the motion of the solar system with reference to the different groups of stars mentioned, as obtained by Strömberg and others, and likewise the fact that the velocity components at right angles to the plane of the Milky Way seem unduly large, will find easier explanation if the observed stellar velocities are in some degree local effects. Our sun and our naked-eye stars and our neighboring stars in general to the number of many millions may compose a veritable star cloud, with resemblances to those observed in our great Milky Way structure, and possibly such as the more or less isolated masses of stars which apparently go

to make up a typical spiral nebula. We do not actually know that the density of distribution of stars in our region of the stellar system is less than it is in some of the distant Milky Way cloud forms. If our sun and our neighboring stars are members of a rich local group of stars the mass of the group as a whole may be sufficient to account for an appreciable component of the motions which we have observed; but I must confess that this is carrying the speculative spirit very far indeed. Fortunately such speculations need do no harm, and they have been known to do good.

I have speculated concerning our stellar system as a spiral nebula, partly as a guard against the assigning of undue weight to the deduced motion of our solar system. The speed and direction of the sun's motion, as here determined, may or may not hold good for the stellar system as a whole. If our local group of stars to which the solution refers composes but a small part of one of the isolated masses in a typical spiral, a knowledge of our motion with reference to the observed group of 2,034 stars may not tell us much concerning our motion with reference to the spiral as a whole. And if our stellar system is not a spiral, but on the contrary a non-rotating, fairly symmetrical system, we should likewise be modest in drawing conclusions as to where our tour amongst the stars is going to carry us, and when we may expect to return. Shapley may be approximately correct in his estimate of 300,000 light years for the diameter of our system, and there may be merit in his surmise that our present place of abode and travel is in a locality situated about 60,000 light years from the center of the system, which center, he suggests, is in the rich Milky Way region of Sagittarius. Now the 2,034 naked-eye stars upon which our solution for the solar motion depends are nearly all within a sphere of radius 500 light years having our sun at its center, and certainly there were no stars used in the solution which are as much as 1,000 light years away. If we represent the stellar system in its greatest dimension by a circle, assuming that its radius is 150,000 light years, and if at some point about two fifths of the way from the center to the circumference we draw with radius 1,000 light years, we shall find that this latter circle is little more than a dot upon the picture. If we represent the stellar system by a circle 300 inches, or 25 feet, in diameter, a circle within it only 2 inches in diameter would in effect contain the 2,034 naked-eye stars used in our solution, and the overwhelming majority of these stars would lie within the central 1 inch[5] of the 2-inch circle.

We know to a degree of accuracy quite satisfactory our sun's motion with respect to a system of 2,034 stars, nearly all giant stars, in our own neighborhood. The elements of the sun's motion as here determined may be, and probably will prove to be, also quite satisfactory with reference to a vastly greater group of stars. That remains to be determined. We can report progress and feel assured that future astronomers, equipped with more powerful instruments and probably with more effective methods, will carry on with stars continually fainter and more distant. It is by the taking of such successive steps that great problems of this kind eventually reach their solution.

W. W. CAMPBELL
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WHAT IS THE SIGNIFICANCE OF TRANSPIRATION?

A LARGE number of research experiments have been carried on dealing with various phases of the subject of plant transpiration, and botanical literature on the subject is voluminous. Most of these experiments have been directed towards a determination of the amounts of water lost by plants and the factors, both internal and environmental, which affect the rate of this loss. It is rather surprising how relatively few have been performed to determine the possible function of transpiration or its influence on the various life processes of the plant. From an inspection of the literature and text-books in botany and allied subjects and from conversation with many teachers and advanced students of botany it is evident that many have given little thought to its significance or they have assumed certain functions without critical examination or thought. I have found that opinions as to the possible value of transpiration to plants vary all the way from those which assume that transpiration results in benefits on a par with those resulting from photosynthesis and respiration to those which ascribe to transpiration practically nothing but harm. Opinions obtained from a large number of advanced students in botany, students who have had their early botanical

[5] Assuming, with Eddington, a density of 10 stars, each equal to our sun in mass, per sphere of diameter 33 light years, a sphere 1,000 light years in diameter would correspondingly contain 270,000 unit stars. A circular disk of space 300,000 light years in diameter and 10,000 light years thick, would similarly contain more than 300,000,000,000 unit stars! We do not seem to be in possession of any facts of observation suggesting that our most powerful telescopes, employed in the manner which enabled them to photograph the most distant star clusters used by Shapley in estimating the diameter of our stellar system, would record more than 3,000,000,000 stars in the system. Are there really good reasons for thinking that the star clouds, or the stars distributed with the same order of frequency as observed in the sun's neighborhood, extend out even to half the distance of the farthest globular clusters thus far observed?

training in many different institutions, indicate that a distinctly large majority consider that transpiration is primarily beneficial to plants and results in relatively ilttle if any injury to them.

In order that there may be no uncertainty with regard to terminology, transpiration as here used will mean the loss of water in vapor form from the plant. Since this loss of water by transpiration may have many distinctive effects on the plant, it may facilitate consideration of them if they are classified under different heads as follows:

(1) Effects resulting from the Influence of Transpiration on the Water Content of the Plant

(a) Since water lost by transpiration can not be instantaneously replaced there must always be at least a slight reduction of the water content and therefore a reduction in turgor. The slight reduction in water content will probably have little influence on the various processes of the plant if there is plenty of water available in the soil and the rate of loss does not greatly exceed that of absorption, but commonly the loss does exceed absorption and, especially when the soil moisture is somewhat deficient, this reduced turgor results in an appreciable check in growth even when no wilting is apparent. Under conditions when the soil moisture is deficient or when there is plenty of water in the soil but transpiration is excessive as on hot, sunny and windy days, this loss through transpiration is almost sure to result in a distinct check in growth and even causes many plants to die. Smith[1] has given a table of estimates which indicate that most crop plants suffer more from deficient water than all other factors combined.

The only conditions under which this reduced turgor may result in benefit to the plant would seem to be when the turgor is so high as to cause rupture or other injury to the tissues. This has occasionally been observed with certain fruits during excessively wet weather, but it seems that the possible occasional benefit resulting from such reduction is many times offset by the commonly injurious results of reduced water content.

(b) Several observers have found that when the water content of the leaf is reduced the stomates often close even before apparent wilting takes place. Loftfield[2] found that during periods of drought the stomates may remain closed much of the day, often closing an hour or two after sunrise. This closure of stomates, whether wilting takes place or not, would in all probability distinctly reduce the rate of entrance of CO_2 and therefore interfere with photosynthesis. The high sugar content resulting from the loss of water would also tend to reduce photosynthesis. Iljin[3] has reported a reduction in photosynthesis of 50 to 78 per cent. in wilting leaves, and Thoday[4] has reported reduction of from 30 to 90 per cent. in leaves having deficient water. Though this reduced photosynthesis would not immediately reduce growth, for the actual sugar content at the time is probably usually high, yet the total sugar made would be so reduced that when water again becomes more abundant the loss can not be made good. This effect of reduced water content resulting from transpiration is evidently primarily harmful.

(c) Any marked reduction in water content of a tissue commonly results in a change in its composition. With some plants the sugar content of the leaves increases to a marked extent. There may be an accumulation of pentosans, a change in the form of protein and of other compounds both organic and inorganic. The types of such changes that occur probably vary greatly with the kind of plant, its stage of growth and also with the environmental factors. Whether the results are beneficial or harmful there is too little evidence to say. One possible benefit of such changed composition is that it makes some plants more resistant to injury from freezing. Plants frequently exposed to freezing weather might therefore be benefited by transpiration, but relatively few plants are exposed to freezes during the growing season and some of them seem to be just as resistant, whether transpiration has been rapid or slow. The check to growth resulting from high transpiration may also make a plant somewhat more resistant to injury during periods of drought, but one would hardly be justified in concluding that transpiration is for this reason beneficial unless one were justified in saying that typhoid is good for people because, if they survive, it makes them more immune to typhoid.

(d) It is sometimes suggested that the check in vegetative growth caused by excess transpiration may hasten maturity and thus enable the plant to escape early frosts. Very little direct evidence is available on this point. It seems that after a plant is well grown the check due to high transpiration might hasten maturity, but I know of no positive evidence showing this. There is some definite evidence avail-

[1] Smith, J. W., "Damage to Crops by Weather," U. S. monthly weather review, 48: 446, 1920.

[2] Loftfield, J. V. G., "The Behavior of Stomata," Carnegie Inst. Wash. pub., 314, 104 pp., 1921.

[3] Iljin, W. S., "Der Einfluss des Wassermangels auf die Kohlenstoffassimilation durch die Pflanzen," *Flora*, 16: 360–378, 1923.

[4] Thoday, D., "Experimental Researches on Vegetable Assimilation and Respiration. VI. Some Experiments on Assimilation in the Open Air," Proc. Roy. Soc., London, 28B: 421–450, 1910.

ble, however, showing that drought, at least in the early stages of growth, distinctly delays maturity. Such data have been obtained by Miss Kibbe[5] for mustard, beans, beets, barley and sweet alyssum and by Thompson[6] for celery.

(2) EFFECTS RESULTING FROM A MOVEMENT OF WATER INTO AND THROUGH THE PLANT

(a) A function frequently ascribed to transpiration is that it is supposed to increase the amount and rate of absorption of nutrients from the soil. It is generally recognized that the soil solution is very dilute and it is therefore natural to assume that rapid transpiration, by increasing the amount of this dilute solution absorbed and passing off the excess water, would correspondingly increase the intake of the needed salts. From theoretical considerations, however, it is evident that solutes and solvent may move through membranes independently. Within recent years a number of experiments have been carried out which tend to show that the amount of solute absorbed by plants bears no direct relation to the amount of water absorbed and lost through transpiration. Muenscher[7] has summarized some of this evidence and has also given additional evidence which shows pretty clearly that transpiration by causing a movement of water into the plant has little or no influence on the absorption of salts. It seems probable that whatever effect transpiration may have on salt content results chiefly from its effect on the water content of the tissue and thereby on the types of chemical reactions occurring there rather than because its absorption mechanically affects salt absorption. Some have suggested that these effects would be different with inessential salts than with essential salts. Such a difference resulting from a mechanical flow of water is however hardly conceivable. Any differences in ash analyses observed could better be explained as resulting from the effects of a changed water content of the tissue on the types of chemical reactions occurring there and therefore on the absorption and accumulation of certain ions.

(b) Though a number have come to realize that nutrient absorption is practically independent of water absorption it is almost universally claimed that transpiration is essential for or at least plays an important part in transferring soil nutrients from the roots to the leaves. If the rate of removal of nutrients from the roots were largely determined by transpiration, then, since the removal of the solutes from the absorbing organ should increase absorption, increased transpiration ought to increase the absorption, but it evidently doesn't. Muenscher actually found on the other hand that plants with high transpiration rates induced by light had less ash in the tops and more in the roots than did those plants with low transpiration.

Still more conclusive evidence tending to show that transpiration has little effect in hastening the transfer of ordinary solutes I have reported in recent papers[8] on the tissues concerned in translocation. This evidence, though perhaps not conclusive, at least clearly indicates that upward movement of solutes occurs chiefly in the phloem tissues. If solutes move upward chiefly through the phloem and are not carried in the water stream, the rate of transpiration can have little direct effect on their movement.

(3) ENERGY CHANGES RESULTING FROM THE CHANGE OF WATER FROM LIQUID TO VAPOR

The change in the physical state of water from liquid to vapor results in an absorption of an appreciable amount of heat, for its heat of vaporation is very great. The water vaporizing within a leaf therefore must tend to lower the temperature of the leaf. The absorption of light by leaves has been found to raise the leaf temperature considerably. It has been repeatedly shown that leaves exposed to bright sunlight may have a temperature of from 5 to 10 or, under special conditions, even 20 degrees centigrade above the air temperature. Tests have indicated that many kinds of leaves if exposed to temperature of 50° C or above for a few minutes are apt to be killed. If, therefore, the air temperature is fairly high, there is a possibility that the leaf may become so heated as to be injured or even killed. Realizing how hot some dark objects become when exposed to direct sunlight and knowing that transpiration has a cooling effect it has naturally been assumed that transpiration plays an important rôle by keeping the leaves cool. It has recently been found, however, that transpiration does not have as great a cooling effect as commonly sup-

[5] Kibbe, Alice L., "Effect of Water Content of Soils on Relative Root and Top Growth of Plants," Thesis for M.S., Cornell, 1920, not published.

[6] Thompson, H. C., "Factors influencing Early Development of Seed Stalk of Celery," Proc. Am. Soc. for Hort. Sci., 1923, 219–224.

[7] Muenscher, W. C., "The Effect of Transpiration on the Absorption of Salts by Plants," *Amer. Jour. Bot.*, 9: 311–329.

[8] Curtis, O. F., "The Upward Translocation of Foods in Plants. I. Tissues concerned in Translocation." *Amer. Jour Bot.*, 7: 101–124, 1920; "The Effect of Ringing a Stem on the Upward Transfer of Nitrogen and Ash Constituents," *Ibid.*, 10: 361–382, 1923; "Studies on the Tissues concerned in the Transfer of Solutes in Plants. The Effects on the Upward Transfer of Solutes of cutting the Xylem as compared with that of cutting the Phloem," *Ann. Bot.*, 39: 573–585, 1925.

posed. Miller,[9] on measuring the temperature of leaves by the use of thermocouples placed on their surfaces, has found that transpiration reduces the temperature of leaves by only 1 to 5° C and Clum,[10] on measuring the temperature of leaves by the use of thermocouples inserted into the leaf, has found that leaves in which transpiration was practically stopped by vaselining or withholding water rarely had temperatures that exceeded the normally transpiring leaves by more than 2 to 4° C. Air currents, the angle at which the leaf was exposed to the sun and the intensity of sunlight had effects on the temperature of the leaf greatly in excess of any cooling effect of transpiration. In no case even in direct sunlight on the hottest days did the temperature of the leaves approach the danger point when the plants were exposed to normal atmospheric conditions, even when transpiration was checked. The rapid loss of heat by conduction to the atmosphere seems sufficiently effective in preventing excessive heating.

The available data, therefore, indicate that the beneficial effects of cooling by transpiration have been greatly exaggerated, as the evidence seems to show that transpiration rarely lowers the temperature more than 2 to 5° centigrade. In fact the injury to plants that frequently occurs on hot days seems to be due chiefly to the injurious drying effects of transpiration itself. Transpiration therefore seems to be more harmful than beneficial on hot days when the cooling effects are most needed. It is notable that commonly those plants best adapted to hot regions are those which have modifications tending to reduce transpiration rather than those which favor it.

(4) Effects resulting from a Reduction of the Water Content of the Soil

Data from many sources are available showing that the water content of the soil is often appreciably decreased as a result of transpiration from the crops growing there. If the soil is so wet that root growth and activity are interfered with this type of drainage would probably be distinctly beneficial, but there is evidence which indicates that, if the soil has too much water, absorption is interfered with and therefore this type of drainage would not take place when most needed. That removal of water from the soil by transpiration often results in injury to the plants growing there is substantiated by abundant evidence.

[9] Miller, E. C., and A. R. Saunders, "Some Observations on the Temperature of the Leaves of Crop Plants," *Jour. Agr. Res.*, 26: 15–43, 1923.

[10] Clum, H. H., "The Effect of Transpiration and Environmental Factors on Leaf Temperatures," Thesis for Ph.D., Cornell, 1924. In press.

(5) Effects often Falsely ascribed to Transpiration

Though it might seem a waste of space to discuss false interpretations for which there are practically no grounds of support, it does seem worth while to touch briefly on a few of the points, for some of them are so frequently cited as functions of transpiration.

(a) It is surprising how frequently students, and teachers also, suggest that transpiration supplies a plant with water, or supplies the leaves with water for photosynthesis, or keeps the cells wet. Such a statement has even crept into a recently published and very reputable college text in botany. The water lost from leaves or from the plant as a whole tends to be replaced by more water entering the roots or rising though the stem. There is always, however, more or less of a lag in this replacement, and it is hardly conceivable that loss from the leaves can increase the supply to them.

(b) Students frequently have the idea that "fresh" water is needed. The only benefit that changing the water could have would be that "fresh" water contained solutes, either gaseous or otherwise, or that the water lost in transpiration carried solutes with it. As previously discussed, however, the available evidence seems to refute this.

(c) It is also often suggested that transpiration keeps the stomates open or that it hastens photosynthesis and respiration. There is, however, no evidence for such statements.

(d) It is sometimes stated that the poor or weak and succulent growth which occurs during cloudy and rainy weather is due to insufficient transpiration. It should be remembered, however, that this weak and succulent growth is probably due not to deficient transpiration but to the fact that photosynthesis has been very much reduced from lack of light. It may be that this failure to distinguish between the effects of high humidity and those of low light intensity accounts for the prevalent idea that drought hastens maturity and that moisture delays it as mentioned in paragraph (d) under the first heading. An unusually wet season at the time the plant approaches maturity is apt to be accompanied by low light intensity and perhaps low temperature which, through their effects on food manufacture, may account for the delay in ripening. If, on the other hand, the season is drier, there is a greater likelihood of higher light intensities and temperatures which, independent of their effects on transpiration or the water supply, may hasten maturity.

In reviewing the available evidence on the possible influences of transpiration on the life processes of a plant it seems that there is little evidence to support many of the supposed benefits and in fact consider-

able evidence tending to show that transpiration very frequently results in considerable harm and rarely if ever has any appreciably beneficial influence. When the water supply is adequate and transpiration is not excessive it probably has little influence on the life processes, but as is so very frequently the case the water in the soil is deficient or transpiration is excessive.

The question may naturally be raised as to why, if transpiration is harmful, natural selection has not eliminated it. This might be answered by saying that many types of modifications do occur tending distinctly to reduce transpiration, and that in many regions plants could not exist without these modifications, but that green land plants could not entirely eliminate transpiration and continue to carry on the essential process of photosynthesis, because for photosynthesis moist cell surfaces must be exposed to the atmosphere to allow for the absorption of CO_2 and the elimination of O_2 and wherever moist cell surfaces are exposed to the atmosphere transpiration must necessarily occur.

I do not advocate that teachers and text-books should dogmatically state that transpiration is primarily harmful and rarely if ever beneficial. I merely wish to point out the fact that statements to the contrary are frequently made and, though many teachers and text-books state that transpiration is probably a necessary evil rather than an advantage, my experience has shown that a large majority of students from many different institutions have the idea that transpiration is essential and primarily beneficial. Usually, however, they can offer but few reasons to uphold their conclusions. Transpiration is one of the most obvious and easily demonstrated processes, and it seems that usually, especially in courses in general botany, more experiments are performed and more discussion is taken up with various phases of transpiration than with any other one process. Often, however, little attention is given to its significance and because of such study the student without giving much thought to it is led to assume that transpiration is a primary function of plants, as is photosynthesis or respiration. That various other physiological processes, especially respiration, are sometimes studied with almost as little thought with respect to their possible functions or significance is also evident.

Otis F. Curtis

Laboratory of Plant Physiology,
Cornell University

THE NAPLES ZOOLOGICAL STATION[1]

Recent reports from the Naples Zoological Station indicate great progress in the development of its work since the reorganization in 1923–24. At the time Dr. Reinhard Dohrn resumed the directorship, after the inter-regnum caused by the war, most of the subscriptions for working-tables made by foreign countries had lapsed, the only tables still maintained being those of Italy, Belgium and England. Since then eight additional countries have resumed their ante-bellum subscriptions, namely, Russia, Japan, Austria, Hungary, Poland, Switzerland, Germany and the United States. The total number of tables has thus increased from 18 to 45, and a further increase is probable this year by subscriptions from other countries. During 1925 more than 100 biologists worked at the laboratory, nine of them Americans of whom several are now in residence at the station, while other applications have been received. An important factor in the recent development of the work at Naples has been a considerable grant from the international education board, used in part to establish traveling scholarships for the benefit of investigators from various countries who without such aid would have been unable to work at the laboratory. Information from various sources, including Dr. Dohrn himself, agree in showing that research at the laboratory is now progressing satisfactorily and that the station has gone far towards becoming once more a truly international center as it was before the war.

This encouraging situation emphasizes the importance of maintaining American support of the station. The extraordinary richness and variety of marine life in the Bay of Naples, together with the excellent equipment and service of the laboratory and library, offers unsurpassed advantages for biological investigation in many of its branches, above all, perhaps, in experimental work; and at least equally important is the unique opportunity offered by residence at the station for personal association with investigators of many nationalities representing the most varied interests. The United States is now maintaining three tables at Naples, one supported by the American Association for the Advancement of Science; one by the Rockefeller Institute for Medical Research, New York, in memory of Jacques Loeb; and one by the Association to Aid Scientific Research by Women. At the present moment all these tables are occupied, but vacancies will arise in the near future and it is also hoped that arrangements may be made whereby temporary overlapping of periods of occupancy by different workers may be provided for, so as to facilitate use of the American tables. Applications for use of the American Association for the Advancement of Science table may be made to Secretary Burton E. Livingston, Smithsonian Institution, Washington, D. C.; for the Jacques Loeb table to Dr. Simon Flexner, Rockefeller Institute, New York City; and for the Women's table to Mrs. Samuel F. Clark, Williamstown, Massachusetts. E. B. W.

[1] An article on the reorganization of the zoological station was published two years ago in this journal, Vol. LIX, No. 152, February 22, 1924.

DR. WELCH AND THE JOHNS HOPKINS UNIVERSITY[1]

Mr. President, Ladies and Gentlemen:

ALMOST half a century ago, Dr. Welch entered upon the course leading him to the choice of pathology as a profession, with the momentous consequences for the advancement of medical science and teaching with which his name is permanently associated.

With amazing insight he perceived, while still a medical student, the profound part which the new cellular pathology was destined to play in the history of medicine. Fortunately for us, and aided by unusual natural abilities, he happily directed his attention to the mastery of that subject.

Although at the outset of his medical career he made use of the opportunities afforded to perfect his training in the clinical branches, he never permitted himself to be diverted from his main objective. He became, therefore, in due time, an accomplished pathologist, possessed of first-hand knowledge of clinical problems and methods, with which unusual though essential combination he entered upon the cultivation of the wide field of pathology by anatomical, physiological, biological and chemical means.

His forerunners and teachers in America and Europe had pursued pathology along particular lines—of morbid anatomy, of histology or bacteriology, or of physiology. It remained for Dr. Welch, fortified by the mastery of all these special disciplines, to establish in Baltimore, at the Johns Hopkins University, a school—the first of its kind—in which all these branches should be united and blended into a school of pathology as broad and complete as the subject itself.

For this remarkable undertaking, Dr. Welch was well equipped by nature. Having inherited a mind of extraordinary vigor, incisiveness and compass, and a judgment almost unerring, his studious habits and powers of concentration, perfected under real masters, quickly yielded him a fund of knowledge, historical and recent, covering many scientific and literary subjects, which he applied with rare skill and charm to the teaching of pathology in its particular and general aspects.

The publications issuing from the pathological laboratory of the Johns Hopkins University during the years of Dr. Welch's professorate, and the many pupils who streamed through its portals, are witnesses to the high activity of that temple of learning. The investigations carried forward in pathology, bacteriology and immunology were varied, numerous and significant; while the men who year by year received their training from him now fill the important chairs of pathology in ever increasing numbers.

Within a generation, through Dr. Welch's influence, pathology in the United States has been elevated from an inconspicuous position in the medical curriculum to the high state to which it is entitled by reason of its importance for advancing the knowledge of disease.

As the first member of the prospective faculty of medicine of the university, Dr. Welch, in association with President Gilman and the trustees of the university and hospital, had a large share in assembling the remarkable group of men who staffed the hospital and started the medical school, and as dean and nestor of the faculty, by his advanced and sound educational views, he fostered that extraordinary development which quickly placed the Johns Hopkins Medical School in the front rank of eminence.

Thus, directly by the example of the achievements of the medical school, and indirectly through his printed addresses, Dr. Welch became the outstanding influence in bringing about the remarkable transformation, material and educational, which has taken place in medical teaching and research in the United States within the past two decades—changes so profound and far-reaching as to be almost without parallel in history.

And most wonderful of all, after his retirement from the professorship of pathology, Dr. Welch organized the School of Hygiene and Public Health, which, in boldness of planning and originality of conception and breadth of execution, stands supreme and unique. Possessed of wide knowledge of similar institutions existing elsewhere, of the complex foundations on which the pursuit of hygiene should rest, and with sympathetic understanding of the leading parts to be played by the newer biology and chemistry in solving public health problems, Dr. Welch brought together a remarkable staff which, under the magic of his influence, and within a very few years, has, by its performances in many fields, rendered the institution world-famous and led to its imitation by other fortunate countries.

As a citizen, Dr. Welch has set a high standard by taking part in many public activities, affecting not only the city of Baltimore, the state of Maryland and the United States at large, but also foreign countries. Many are the projects that have benefited by his wise and disinterested counsel.

On the 8th of April, 1925, Dr. Welch celebrated his seventy-fifth birthday. A group of his friends, among whom I am happy to state are numbered the president and trustees of this university, desired to commemorate the event in an adequate manner. With his

[1] Address given on the occasion of the unveiling of a bust of Dr. William H. Welch at the commemoration day exercises of the Johns Hopkins University on February 22.

usual graciousness, Dr. Welch fell in with the plans, and, after due consideration, it was decided that the purposes and wishes of the group could best be met by the execution of a portrait bust, to be presented to the Johns Hopkins University and ultimately to be placed, if it is deemed wise, at the medical school. The university already possesses a portrait in oil of Dr. Welch, executed by a great artist. The committee, Mr. President, entrusted with the responsibility, believes that in Mr. Konenkov's bust of Dr. Welch a masterpiece of sculpture has been produced. It is the hope of the committee that, in the discretion of the president and board of trustees of the university, this bust may be so exhibited that succeeding generations without end of teachers and students may come to view it. In contemplating its fine features, its strength and its wisdom, they will be reminded of the great teacher and citizen whose long and noble life's work is being devoted unselfishly, generously and kindly, successfully and modestly, to the advancement of knowledge and to the upbuilding of a school of medicine and allied sciences which has become a model for the world; perchance they will be reminded also that in making others strong resides the greatest strength and the most enduring happiness.

Simon Flexner

The Rockefeller Institute for Medical Research

SCIENTIFIC EVENTS

SITE FOR NEW SOLAR OBSERVATION STATION OF THE SMITHSONIAN ASTROPHYSICAL OBSERVATORY

According to a statement received from the Smithsonian Institution, Dr. C. G. Abbot, assistant secretary of the institution and director of the Smithsonian Astrophysical Observatory, has found, near Quetta, in British Baluchistan, the most suitable site that he has seen thus far in his search of the Eastern Hemisphere for a place to locate a new solar observation station. This new station, to be erected by the Smithsonian Institution with funds provided by the National Geographic Society, will be the third under the direction of the Smithsonian Institution which makes daily observations of the variable radiation of the sun, the other two being located in Chile and California.

This third station will furnish a needed check on the values from the other two, providing a more dependable daily value of the solar constant. It is hoped that accurate long-range weather forecasting may become possible as a result of this work by the Smithsonian Institution.

Dr. Abbot has visited the Sahara Desert and India and now is on his way to Southwestern Africa. In a letter from Quetta, received by Dr. Charles D. Walcott, secretary of the Smithsonian Institution, Dr. Abbot says:

From Delhi we made a two days' journey through a sandy desert and up into the barren mountains of Baluchistan to Quetta. We had expected to find Arctic weather in view of the accounts of many informants, but Washington winters are far more severe. Unfortunately we arrived on the eve of the first considerable rain they have had since September, and in the five days since we came it has rained or snowed four. The snow was only a half inch or so and is now gone at Quetta but the mountains about are all snow-covered now.

For the observatory site we have fixed upon Khojak Pass over which Lord Roberts' army dragged their guns in the Afghan war. The railroad now tunnels the pass, and a garrison of 2,000 troops holds Chaman about 10 miles beyond. There are detachments at both ends of the 2-mile tunnel. The peak is 7,525 feet high and overlooks Afghanistan deserts for a hundred miles, as well as the great valley to the east.

The location selected is wonderfully accessible. The military road runs over the pass, and a graded path nearly wide enough for autos runs ¾ mile to within a few feet of the peak. It will be possible to widen it at small expense and thus the observers can live at the eastern end of the tunnel in some comfort and ride up to observe in about 20 minutes each morning. In a half hour the boys can ride to Chaman and in 2½ hours to Quetta. A three-days' railroad journey will bring them to the most interesting sights of India.

Quetta has no grass, but many fruit trees. The climate is as fine as anywhere in the world excepting only this week. Neither too hot nor too cold.

THE TULSA MEETING OF THE AMERICAN CHEMICAL SOCIETY

The seventy-first meeting of the American Chemical Society will be held in Tulsa, Okla., from April 5 to 8. The preliminary program follows:

Monday, April 5

10:00 A. M. Registration bureau opens on sixteenth floor, Mayo Hotel.
10:00 A. M. Meeting of senate of chemical education, sixteenth floor, Mayo Hotel.
2:00 P. M. Council meeting—Mayo Hotel.
8:00 P. M. Smoker and entertainment—Mayo Hotel.

Tuesday, April 6

10:00 A. M. General business meeting—Mayo Hotel.
11:00 A. M. General meeting—crystal ball room, Mayo Hotel.

Addresses by:

D. W. Moffit, vice-president, Mid-continent Petroleum Co., "Research Opportunity."

Cyrus S. Arney, highway commissioner, "What Oklahoma has to Offer."

Response by:
James F. Norris, president of the American Chemical Society.

2:30 P. M. Divisional general programs by the industrial and petroleum, the physical and inorganic, and the chemical education divisions at Mayo Hotel. These include Symposia on "Lubrication" and on "Orientation and Segregation as applied in Chemical Education."

6:00 P. M. Dinner of petroleum division and other group dinners.

8:30 P. M. Public Address, "The Romance of Carbon," by A. D. Little, of A. D. Little, Inc., Boston.

Wednesday, April 7

9:30 A. M. Divisional meetings at Mayo Hotel.

2:00 P. M. Divisional meetings, continued.

7:30 P. M. Banquet—Mayo Hotel.

Thursday, April 8

Excursions.

All divisions, except the fertilizer, leather and gelatin, rubber and sugar divisions, will meet. The paint and varnish section also will not meet at this time, but is planning a special meeting in May at a regional meeting to be held in Madison, Wis.

The industrial division and the petroleum division will hold on Tuesday afternoon a joint symposium on lubrication, with Robert E. Wilson as chairman. Contributions from some of the best authors on lubrication, both American and foreign, will be presented. Papers on special lubrication problems will also be included, together with a discussion of lubrication theory and practice. Dr. A. E. Dunstan, the eminent English author on lubrication, will be present and will give at least one paper. The symposium will begin Tuesday afternoon and continue through Wednesday.

The divisions of organic chemistry, dye chemistry and the chemistry of medicinal products will meet in joint session, with the opening session on Wednesday morning. A half day of the session will be devoted to a symposium on aliphatic chemistry. One of the features of the session with the division of medicinal products will be an address by Marston T. Bogert, of the National Research Council, on the work of his committee on chemical research on medicinal substances.

Plans for the division of chemical education at the Tulsa meeting include three sessions: First, a symposium on "Orientation and Segregation as applied in Chemical Education"; second, a joint session with the section of the history of chemistry, and, third, a session devoted to topics of general interest to chemistry teachers in all branches of the subject. A special effort is being made to interest the chemistry teachers of the southwest and indications point to a good attendance and an interesting meeting.

The divisions of agricultural and food chemistry, cellulose chemistry and biological chemistry will meet jointly, and on Wednesday morning, together with the division of industrial and engineering chemistry, will hold a symposium under the chairmanship of David Wesson on the topic of "Chemistry of Cotton, Cotton Seed Products and Vegetable Oils."

The group of local section chairmen and secretaries, with H. N. Holmes presiding and E. M. Billings as secretary, will meet at a time to be announced in the final program.

The addresses of the secretaries of the divisions and sections which will hold meetings are as follows:

Agricultural and Food Chemistry, C. S. Brinton, U. S. Food Inspection Station, 134 S. 2nd St., Philadelphia, Pa.

Biological Chemistry, J. J. Willaman, University Farm, St. Paul, Minn.

Cellulose Chemistry, L. F. Hawley, Forest Products Laboratory, Madison, Wis.

Chemical Education, B. S. Hopkins, University of Illinois, Urbana, Ill.

Dye Chemistry, O. E. Roberts, Jr., 813 Ingraham St., Washington, D. C.

Gas and Fuel Chemistry, O. O. Malleis, 333 Melwood St., Pittsburgh, Pa.

Industrial and Engineering Chemistry, E. M. Billings, Kodak Park, Rochester, N. Y.

Chemistry of Medicinal Products, A. W. Dox, Research Laboratory, Parke, Davis & Co., Detroit, Mich.

Organic Chemistry, Frank C. Whitmore, 1812 Chicago Ave., Evanston, Ill.

Petroleum Chemistry, G. A. Burrell, 120 Ruskin Ave., Pittsburgh, Pa.

Physical and Inorganic Chemistry, G. L. Clark, Research Laboratory Applied Chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

Water, Sewage and Sanitation Chemistry, F. R. Georgia, Department of Chemistry, Cornell Univ., Ithaca, N. Y.

History of Chemistry, L. C. Newell, 688 Boylston St., Boston, Mass.

THE MORDEN-CLARK ASIATIC EXPEDITION OF THE AMERICAN MUSEUM

James L. Clark, assistant director in charge of preparation at the American Museum of Natural History, has sailed for London, from which place he will go to Marseilles to join William J. Morden, of Chicago, through whose generosity there has been made possible the Morden-Clark Asiatic Expedition.

Messrs. Morden and Clark will arrive in Bombay about March 19 and will proceed up to Srinagar, Kashmir, where they will secure their guides and

the balance of their outfit. From Srinagar they will go some 200 miles to Gilgit, then to Hunza in the uppermost part of India, arriving about April 15. Here they will wait at the foot of the Himalayas until the higher and dangerous passes open up enough to permit them to go through into the back country.

The purpose of the trip is a reconnaissance of the south-central Asia section and to lay out for the future other expeditions to be carried on in localities of this country where the short season will not permit the expedition to touch at this time.

Through the generosity of Mr. A. S. Vernay and Colonel J. C. Faunthorpe, the museum has received a most magnificent collection of the big game of the plains of India which is now about complete in its mounting. Far to the east, in China, the Third Asiatic Expedition of the Museum has collected the great game of that country, but in between lies a great gap, previously mentioned, which has been untouched and which the American Museum is most desirous of closing in so far as its collections are now represented. These countries are so large that it will take years to complete this work, but the start is now being made.

It is the plan of the museum to show the great game of Asia in a series of large habitat groups with painted panoramic backgrounds, perfectly rendered ground work and foliage, in order that the mounted animals may be depicted in the natural and colorful settings from which they come. This work will take years, but, under the direction of Mr. Clark, the museum is organizing a large staff of artists to carry on this work, which will be done by the most modern scientific methods of mounting and installation.

Photography—both still and motion pictures, taken with an Akeley camera, will be a feature of the trip, and it is planned to bring back photographic material, not only for the use of the artists in the construction of these great groups, but also for use in the extensive educational program that the museum is carrying on for the school children of New York. Field notes of many kinds, such as sketches, color notes and records, will supplement the photographs and other data.

THE WORLD'S POULTRY CONGRESS

POULTRY scientists and leaders of the poultry industry in every land are looking forward with interest to the World's Poultry Congress, which is to be held in Canada from July 27 to August 4, 1927. This will be the first international poultry meeting to be held in America. It will also represent the most thoroughgoing attempt ever made in any country to get together at one series of sessions the best thought bearing on every phase of poultry husbandry.

These congresses, which are held every three years, are planned to accomplish a dual purpose—to bring together the newer knowledge applicable to the production, manufacture, distribution and use of poultry products and to increase the interest of consumers in a wiser use of these products. The members of the various branches of the poultry industry of the United States will have a peculiar interest in the coming congress because it is being held "next door" and probably will not be held on this side of the Atlantic for from six to nine years.

It is believed that the proposed congress will be of great value to all participating countries, both from a scientific and commercial standpoint, by bringing together the leading men of scientific and commercial experience for the consideration of all the larger problems involved, with the view of making available the best information in existence concerning the importance of poultry, meat and eggs, especially to the consumer, as well as the most effective and economic method of production, distribution and official regulation.

RESOLUTION ON THE DEATH OF CHARLES AVERY DOREMUS

AT the meeting of the New York Section of the American Chemical Society on January 8, 1926, the following resolution was adopted:

WHEREAS, The members of the New York Section of the American Chemical Society have heard with deep regret of the death of Dr. Charles Avery Doremus, a charter member of the American Chemical Society and of this section, and of the Chemists' Club of New York City, and

WHEREAS, Dr. Doremus has been for more than fifty years an active worker in chemistry, beginning with his graduation at the College of the City of New York and followed by the degree conferred by the University of Heidelberg and Leipzig, and by the teaching of medical chemistry and toxicology in Bellevue Medical School in New York and in the Medical School of the University of Buffalo, and by prolonged service as assistant professor to professor of chemistry as successor to his father, the late Dr. Robert Ogden Doremus, in the College of the City of New York for twenty-two years, and further, after his retirement from teaching in 1904, in the practice of consulting chemistry in New York City, and in the publication of chemical papers, beginning with an article in the *Proceedings of the American Chemical Society* in 1876, and of later contributions during his life to the *Journal of the American Chemical Society*, and in other chemical journals. Therefore, it is

Resolved, That the influence of Dr. Doremus as a teacher and a worker in many fields of chemical interest is long to be remembered and that the members of this section hereby express their respect for his memory and esteem for him as a colleague and as a brother in the chemical profession.

Resolved further, That the sympathy and condolence of

the members of this section be extended to the relatives and friends of Dr. Doremus and that these resolutions be recorded in the archives of this section and that a copy of the same be presented to the widow of our deceased member.

SCIENTIFIC NOTES AND NEWS

THE John Fritz Medal Board of Award, representing the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, announces the presentation of the John Fritz gold medal to Edward Dean Adams, "engineer, financier, scientist, whose vision, courage and industry made possible at Niagara Falls the birth of hydro-electric power," in the Engineering Auditorium, New York, on Tuesday evening, March 30, 1926, at 8.15 o'clock. The speakers are Lieutenant-Colonel Frank B. Jewett, chairman of the John Fritz Medal Board of Award, presiding; the Hon. James M. Beck, formerly solicitor-general of the United States; Dr. Arthur Edwin Kennelly, professor of electrical engineering, Harvard University and Massachusetts Institute of Technology; Major Fred J. Miller, former chairman of the board, and Edward Dean Adams, medalist.

FRIENDS of Professor Chandler presented in 1910 to the trustees of Columbia University a sum of money which constitutes the Charles Frederick Chandler Foundation. The income from this fund is used to provide a lecture by an eminent chemist and to provide a medal to be presented to the lecturer in further recognition of his achievements in science. Previous lecturers under this foundation were: Drs. L. H. Baekeland, W. F. Hildebrand, W. R. Whitney, F. Gowland Hopkins, Edgar F. Smith, Robert E. Swain and E. C. Kendall. The lecturer for 1926 will be Samuel W. Parr, professor of chemistry at the University of Illinois, whose subject will be "The Constitution of Coal." The lecture will be in Havemeyer Hall, Columbia University, on Friday, April 23, at 8:15.

SEVEN American universities have selected as their international exchange professor to France Dr. John B. Whitehead, dean of the Johns Hopkins School of Engineering. His appointment was arranged by Harvard, Yale, Columbia, Cornell, the University of Pennsylvania, the Massachusetts Institute of Technology, the Johns Hopkins and the French government, establishing an exchange professorship of engineering and applied science between the two countries. During the last four years the American universities have sent France Professors Emile M. Chamot, of Cornell University; A. E. Kennelly, of Harvard University; Douglas W. Johnson, of Columbia University, and John Frazer, of the University of Pennsylvania. In the same period Professors J. Cavallier, Emmanuel de Margerie and Pierre Lemair were sent by France to lecture in the United States.

FREDERICK E. IVES, of Philadelphia, has been awarded the medal of the United Typothetae of America for his invention of the half-tone process of photoengraving.

R. S. DEAN, of the Hawthorne plant of the Western Electric Co., has been awarded a medal, by the American Institute of Mining Engineers, for his discovery of a process for hardening lead. Presentation of the medal was made at a dinner at the Chemists Club, New York, on March 2.

THE decoration of the order, Ridder af Dannebrog, has been conferred on Dr. J. A. Detlefsen, professor of genetics at the Wistar Institute, and associate editor of *Biological Abstracts.*

A GENUS of Australian diptera has been named *Benjaminella* in honor of Dr. Marcus Benjamin, editor of the *Proceedings* of the United States National Museum, by Mr. J. R. Malloch in a paper presented before the Linnean Society of New South Wales. The genotype of the new genus is *Benjaminella albifacies.*

DR. KARL LANDSTEINER, of the Rockefeller Institute, New York, has been elected a foreign member of the Swedish Medical Association.

DR. CHRISTINE LADD FRANKLIN, lecturer in psychology at Columbia University, was presented with a Ph.D. diploma on the occasion of the commemoration day exercises at the Johns Hopkins University on February 22. Mrs. Franklin qualified for the degree forty-four years ago, but could not receive it because the university at that time conferred no degrees upon women students.

M. EMILE PICARD, the eminent French mathematician, was received in the French Academy on March 11, taking the place left vacant by the death of M. Charles de Freycinet. He was introduced by Marshal Foch and M. Jules Cambon.

CAMBRIDGE UNIVERSITY has conferred upon Sir T. W. Edgeworth, professor of geology in the University of Sydney, the honorary degree of doctor of science.

THE president and council of the Royal Society have recommended for election into the society the following fifteen candidates: Dr. Joseph Arthur Arkwright, Dr. Edwin John Butler, Lieutenant-Colonel Samuel Rickard Christophers, Professor Frank Joseph Cole, Mr. Alfred Charles Glyn Egerton, Dr.

Ezer Griffiths, Mr. Harold Brewer Hartley, Dr. Hamilton Hartridge, Professor George Barker Jeffery, Professor Owen Thomas Jones, Professor William Cudmore McCullagh Lewis, Professor Edward Arthur Milne, Mr. Lewis Fry Richardson, Mr. Henry Thomas Tizard, Professor Robert Scott Troup.

PROFESSOR A. S. EDDINGTON, F.R.S., Plumian professor of astronomy at the University of Cambridge, has been elected a member of the Athenæum for "distinguished eminence in science."

THE Institution of Petroleum Technologists, England, has awarded the Boverton Redwood Medal for sessions 1923–24 and 1924–25 to C. H. McCarthy-Jones, for his paper entitled "Electricity applied to the winning of Crude Petroleum, with Special Reference to the Yenang-yaung Field, Burma."

PROFESSOR F. E. WEISS, Harrison professor of botany in the University of Manchester, has been elected an honorary member of the Botanical Society of Geneva.

DR. FRIDTJOF NANSEN, the polar explorer, has been named Norway's principal delegate to the League of Nations meetings at Geneva.

DR. J. H. JEANS was elected president of the Royal Astronomical Society at the annual meeting on February 12.

DR. CHARLES E. MUNROE, professor of chemistry and dean of the faculty of graduate studies, *emeritus*, of the George Washington University, under the authority of the Secretary of War, has been appointed a research consultant of the Chemical Warfare Service to assist in the solution of problems that have to do with the investigations and developments under way in this branch of the U. S. army.

CHARLES M. RATH was recently elected president of the Rocky Mountain Association of Petroleum Geologists.

DR. JOHN A. COMSTOCK, for the last five years a director of the Southwest Museum, Los Angeles, has resigned in order to resume the practice of medicine.

DR. KRÄPELIN, professor of psychiatry at the University of Munich, recently celebrated his seventieth birthday.

IN commemoration of the thirtieth anniversary of his appointment to the Bucarest Faculty of Medicine, Dr. T. Jonnesco received February 21 a presentation volume containing an account of his life together with a congratulatory address.

PROFESSOR HANS EPPINGER, formerly the first assistant of Professor Wenckebach in the medical clinic at Vienna, has succeeded Professor de la Camp as director of the medical clinic at Freiburg.

ROBERT CALVERT, professor of industrial chemistry at the University of Maryland, has been granted leave of absence and will become chief chemist for the Van Schaack Brothers Chemical Works, of Chicago.

PAUL G. REDINGTON, for the past five years district forester in charge of the national forests in California, has been selected to head the public relations work of the U. S. Forest Service.

ROY CHAPMAN ANDREWS, the explorer, left on February 27 for China, to organize the fourth expedition of the American Museum of Natural History into the Gobi Desert where a special search will be made for early human remains. With automobiles and camels, the party will start early next spring into Mongolia.

DR. ROBERT A. LAMBERT, of New York, will leave for Porto Rico about the middle of March to become the head of the School of Tropical Medicine now being established on the island by Columbia University.

DR. MANUEL L. ROXAS, head of the department of agricultural chemistry at the University of the Philippines, has been granted leave and is now working for the Philippine Sugar Association as director of the Luzon Cane Field Testing Department. Dr. F. O. Santos has been appointed acting head of the department.

DR. JAYME PEREIRA has returned to Rio de Janeiro after two years of graduate study of physiology at Harvard University and Woods Hole, on a Rockefeller fellowship, with one year in the laboratories of Europe.

OLOF G. JONASSON, of the faculty of the University of Stockholm, who has been a graduate student at Clark University during the last two years, received the degree of Ph.D. on February 1. He is planning to spend a period of study in Washington and return to the University of Stockholm to resume work on the faculty of that university at the beginning of the next academic year.

PROFESSOR ERNST COHEN, of the University of Utrecht, Holland, has arrived in Ithaca, to take up his duties as non-resident lecturer in chemistry at Cornell University for the term.

PROFESSOR TH. DEDONDER, of the University of Brussels, will arrive at the Massachusetts Institute of Technology on March 22, to give two series of lectures. One series will be on the subject of relativity and the other on the mathematical theory of electricity.

Two Swedish professors, Henrik Hesselman and Tor Jonson, have been invited by American forestry

institutions to come to the United States this winter to give information on Swedish methods of forest conservation.

DR. A. CEBALLOS, professor of surgical pathology at Buenos Aires, is visiting medical centers in the United States.

DR. MICHAEL I. PUPIN, president of the American Institute of Electrical Engineers, will deliver the charter day address at the University of California on March 23.

COLONEL E. L. JONES, director of the United States Coast and Geodetic Survey, will give a lecture at the Franklin Institute on March 17 on the subject of "Science and the Earthquake Peril."

DR. ARTHUR D. LITTLE delivered an address, "The Application of Research to Industrial Development," before the Swarthmore chapter of Sigma Xi on February 2 at Swarthmore College.

DR. W. J. HUMPHREYS, meteorological physicist of the U. S. Weather Bureau, gave an illustrated lecture on "Clouds and Cloud Phenomena" under the auspices of the Sigma Xi fraternity at McGill University, Montreal, on February 25.

PROFESSOR HENRY FAIRFIELD OSBORN, director of the American Museum of Natural History, gave an address on "Convincing Evidence of the Geologic Antiquity and Creative Evolution of Man" at Cornell University on February 19.

DR. CHAS. P. BERKEY, professor of geology at Columbia University and for the past two seasons geologist with the Third Asiatic Expedition of the American Museum of Natural History, described the results of his explorations in the desert of Gobi, in Mongolia, with this expedition, in a lecture at the Missouri School of Mines and Metallurgy on March 3.

PROFESSOR HERBERT OSBORN, of the Ohio State University, gave an illustrated address on "Early Workers in American Entomology" before the Sigma Xi Club and the Entomological Society of the University of Florida on the evening of March 1.

ON February 20, Dr. A. P. Coleman, department of geology, University of Toronto, delivered an address to the Royal Canadian Institute on the subject "The Earth as the Heat Engine."

PROFESSOR F. E. LLOYD, of McGill University, lectured before the University of Illinois on March 3 and 4 on "Romance and Tragedy under the Microscope," with motion pictures showing the activities of Spirogyra and Vampyrella, and on "The Fluorescence of Living Plants," with a demonstration of results obtained with dark-field illumination.

PROFESSOR W. CHATTIN WETHERILL, of the department of mechanical engineering of the University of Pennsylvania, lectured before the Franklin Institute on March 11, on the subject of "The Elimination of Waste in Industry."

F. C. BISHOPP, in charge of the work of the U. S. Bureau of Entomology on insects affecting live stock, gave a series of talks on the external parasites of domestic animals and poultry at the Iowa State College during the farmers' short course which was held at Ames, February 1 to 6. At a dinner of the Osborn Research Club of the same institution on February 1 he gave an illustrated lecture on "Myiasis and Related Skin Afflictions of Man in the United States."

DR. EDWARD UHLENHUTH, associate professor of anatomy at the University of Maryland Medical School and formerly of Rockefeller Institute, gave a lecture on "The Secretion Process in the Thyroid Gland," on March 4, at George Washington University, Washington, D. C., before the Association of the Scientific Personnel of the Public Health Service.

PROFESSOR CHARLES-EDWARD A. WINSLOW, of Yale University, president of the American Public Health Association, spoke on "The Health Department and the Individual" at the annual dinner of the Boston Health League, on February 17.

DR. SUTHERLAND SIMPSON, professor and head of the department of physiology and biochemistry at Cornell University, Ithaca, died on March 3, aged sixty-three years.

UNIVERSITY AND EDUCATIONAL NOTES

THE late William W. Crapo, of New Bedford, Mass., among other bequests has left $100,000 to Yale University.

ACCORDING to press reports, the regents of the University of Wisconsin have issued instructions to prepare plans to expend about $1,500,000 on a new building and equipment for the University of Wisconsin Medical School; the first unit will cost about $450,000; bids will be issued by July 1.

MAJOR MAX TOLTZ, of St. Paul, Minn., has given $15,000 to the American Society of Mechanical Engineers to establish a fund for the assistance of students in engineering.

ON February 2, Oxford University confirmed a decree authorizing a special allowance of £200 a year, in addition to his ordinary stipend, to each professor being the head of a scientific department.

PROFESSOR J. H. FRANDSEN has been elected head of the department of dairying and animal husbandry at the Massachusetts Agricultural College.

Dr. Llewellyn T. Spencer has been promoted to assistant professor of psychology at Yale University.

At the Harvard Dental School, Dr. Frank T. Taylor has been promoted to clinical professor of operative dentistry and Dr. Percy R. Howe has been appointed Thomas A. Forsyth professor of dental science.

Dr. Vicente G. Lava, Ph.D. in physical chemistry from Columbia University, has been appointed associate professor of agricultural chemistry at the University of the Philippines.

Dr. John Samuel Dunkerly, senior lecturer in zoology in the University of Glasgow, has been appointed Beyer professor of zoology and director of the zoological laboratory at the University of Manchester, in succession to Professor Hickson, who will retire in September.

L. G. Sims has been appointed lecturer in electrical engineering at the University of Birmingham, vice Dr. O. R. Randall, who has been appointed professor of electrotechnics at the Witwatersrand University, Johannesburg.

Professor W. Fischer, director of the Pathological Institute at Rostock, has been elected rector of the Rostock Medical Faculty.

DISCUSSION AND CORRESPONDENCE

SCIENTISTS AND THE INCOME TAX

Acting on the request of the executive committee of the American Association for the Advancement of Science, I have tried to assemble such information as may be had regarding the operation of the income tax on scientists. It is assumed that the general provisions are easily understood, such as, individuals required to file returns, exemptions on account of family relationships, etc., but in applying the general provisions of the law to scientists some points have come up that have required interpretation. This report is intended to deal only with these less obvious matters.

One feature chiefly has raised questions of doubt, that of exemptions. In 1924, Committee O, of the American Association of University Professors, with the help of Professor Thomas S. Adams, of Yale University, undertook to secure solutions of several of these problems. The results of this inquiry were published in the *Bulletin* of that association in December, 1924.

Similar inquiries have been made for the engineering profession and the substance of the result was published in the Proceedings of the American Society of Civil Engineers, Vol. 52: 72, 1926.

The American Medical Association has carried on an active investigation into the relation of the income tax to physicians, the outcome of which was summed up in the *Journal of the American Medical Association*, Vol. 84: 446–448, 1925 (Feb. 7).

Since these groups have much in common and since rulings made on test cases brought out in one group often clarify the situation for the others, an attempt has been made here to present briefly the substance of pertinent decisions made on points involving scientists. In this I have tried to follow closely the authoritative wording where practicable.

Society Dues

Dues paid to charitable and professional organizations not run for profit are deductions permitted in computing the tax. All dues paid during the taxable year are included. This deduction should be made on the income tax blank entry under business expense.

Traveling Expenses

While business men and engineers traveling solely for business purposes may deduct travel expenses, including cost of entertaining others, when it can be shown that the sums were spent on prospective clients, physicians attending medical conventions and scientists attending scientific meetings may not deduct traveling expenses. In the latter case these exemptions are regarded as personal expenses not undertaken in the hope of profit as a major consideration.

When, however, a member of a college or university faculty while on sabbatical leave travels, "especially for the purpose of study, travel and research work," the information gathered being used to supplement courses of study on which they usually prepare a report to their superiors, traveling expenses incurred are allowable deductions from gross income. This is considered as comparable to the case of a clergyman whose traveling expenses incurred in attending a general convention of the church are deductible from gross income.

Scientists, traveling as experts in connection with their profession, are allowed to deduct traveling expenses on the same basis as the faculty member traveling on sabbatical leave referred to above.

Salaries of Stenographers, Clerks, etc., Stationery, Office Supplies and Equipment

When college professors employ stenographers and clerks in connection with the activities from which they derive their income directly, the salaries paid by them are deductible, as also sums paid personally for stationery, office supplies and equipment.

Attendance on Summer Schools, Post-graduate Courses, etc.

Although college and university people attend sum-

mer schools and do post-graduate work in the hope thereby of increasing their knowledge and value as teachers and researchers, and of securing for themselves advancement with higher salaries, the Commissioner of Internal Revenue rules that the cost of such study is a personal expense and not deductible.

Depreciation of Library, Apparatus and other Professional Equipment

While the situation on this point is not altogether clear, decisions in the main favor an allowance for depreciation, particularly where the taxpayer derives a material income from expert work.

From what has been said, it appears clear that in the administration of the income tax law, the scientist suffers in the matter of exemptions because of the absence of the idea of financial gain from his doings. He is regarded by the law as interpreted to be doing it all for his personal satisfaction, for which satisfaction he must pay. When his operations are dictated by a desire to make money, a taxpayer may claim and secure many exemptions denied to the scientist.

It is hoped that the further development of this subject, through decisions and otherwise, may be followed up and reported as matters of interest appears.

Rodney H. True,
Secretary, Committee of One Hundred

EDWARD SYLVESTER MORSE

I was greatly pleased at the beautiful tribute paid to my dear friend, Edward Sylvester Morse. May I add a word of appreciation:

I first met Professor Morse at a meeting of the Association for the Advancement of Science, at Indianapolis, in 1871. Dr. P. H. Jameson, leading physician at Indianapolis at the time, gave a dinner to some of the visiting scientists and invited me to attend. It was at this dinner that I met Professor Morse. It was my good fortune to have his sincere friendship during all these remaining years. In 1923 my wife drove me and my boys to Cambridge to attend my fiftieth anniversary. On the day following the commencement, Professor Charles L. Jackson, emeritus professor of chemistry at Harvard, and one of my teachers when I was there, invited my family to dine with him at his summer home at Pride's Crossing. We went through Salem en route. I drove to the museum to see my old friend and learned that he was emeritus, but that he was in the museum nearly every day. The attendant said that if I would wait until he could be called up, he certainly would come down to see me. Over the telephone, he said, "I will be down in a few minutes." He was still just the same boy that he was when I first met him fifty-two years before. He was particularly interested in my boys, who, at the time, were nine and eleven years of age. He showed them all his precious possessions from Japan. He illustrated, at my request, how he could draw on the blackboard with the right and left hand at the same time. He was just as much of a boy as my two boys were, and they have spoken of him continually since.

I am glad that, as this was the last time I saw him, it was under those circumstances which illustrated those very traits of character which Dr. Dall has so vividly described. The memory of this last meeting will, of course, always be as vivid to me as the first time I saw him. His life was typical of how a devotee of science may at the same time be warm-hearted, wideawake and an interesting human being.

H. W. Wiley

Washington, D. C.

THE AMATEUR SCIENTIST IN THE ACADEMIC WORLD

At first glance, the things we do are divided into two classes: those we do from a desire within and those we do by virtue of some sort of compulsion from without.

Like most attempts at classification, however, this is incomplete. The two categories are not mutually exclusive, but the statement can nevertheless be taken as a useful first approximation.

The world's largest manufacturer of photographic goods has described himself as "an amateur photographer." Nor is this simply an exhibition of shrinking modesty; it is a statement of motive. It classifies his professional activity in the former of the two categories mentioned above. And he is fortunate, of course, who finds himself in such a position.

It is obvious, on a moment's reflection, that an "amateur" is not one who is any the less skilful or trained than a "professional," but is rather one whose motive for doing a thing is activated by the pure love of doing it.

Now a person's pursuit may be ever so laudable and still not be "amateurish" (being careful to divest that word of its inferiority complex). Even the teacher, the preacher or the missionary may be responding to the call of duty rather than to an inner urge.

Psychologically speaking, there are doubtless many "activators" or precursors of desire, but one of the most potent of these is curiosity. In and by itself it has led men to explore the world, delve into the earth, analyze, synthesize, create. It has been the silent watchword running through the whole history of science, and nothing will ever take its place in this field. Nothing but the irresistible urge to *know* could

have led Roger Bacon, Galileo and others to risk the ecclesiastical tortures of their times.

But times have changed, and it is now more respectable—nay, even laudable—to indulge one's curiosity. But with the increasing complexity of our modern conditions other motives become active, and even subtle compulsions invade the fields in which unfettered curiosity once foraged freely.

Not only have we seen a growing, and to a very large extent illogical, distinction between pure and applied science, but even so-called "pure" scientific research is becoming a recognized *business*. For a long time it has shown the competitive earmarks.

Well and good. All power to the world's progress! With all our wailing over "the good old days" we would not go back to the horse-car and the oil-lamp if we could. And suffice it to say, we can't, anyway. The world may move in cycles, as in Oriental cosmogony, but it certainly does not retrograde in straight lines.

But whatever embellishments may now adorn the armor of the scientific knight-errant in search of truth, let us not forget that his sword and primary resource is the keen desire to know—good old-fashioned curiosity.

Not for the first time have we heard complaint against the condition in our colleges and universities which makes it necessary for the young scientific aspirant to "grind the paper mill" in order to insure his continuance—to say nothing of advancement—in the academic-scientific field. This is certainly one of the reasons why young men yield to the persuasions of industry, where the desire to know is admittedly diluted to a high degree by the desire for pecuniary gain.

The publication of scientific papers is not only desirable but absolutely essential for the progress of science, and no one of us would wish to stem that stream of discovered knowledge which has in the past and is now helping to cultivate every field of the world's activity. "Keeping up with the literature," however, in the larger scientific fields is becoming a difficult problem, and the difficulty is increasing in geometrical progression. Nevertheless, the quantity is not a cause for concern; we will find some way of solving the difficulty when it becomes acute.

But many of us have had the experience of wading through tons of chaff in search of a few grains of wheat. One can not always avoid the suspicion that some—perhaps a goodly portion—of this material has been turned out for other reasons than those which have traditionally motivated true scientific inquiry.

And where, pray, should the bulwark of true scientific inquiry be found if not in our colleges and universities? Nor is the fundamental scientific spirit of our many independent research institutions to be impeached. We may confidently assume that in these the business of scientific investigation will successfully be combined with the amateur motive. At any rate, we are not now concerned with them.

But the college and the university have a deeper responsibility. It is theirs—among other functions—not only to perpetuate science itself but the *spirit* of science as well. And that spirit is incompatible with anything but an absolute freedom of intellectual interest and curiosity. The moment compulsions enter that spirit begins to fade. No professor of science will do justice to himself who is being urged to think of what is encumbent upon him, ex-officio, by virtue of his position. Nor can a professor who is "grinding the paper mill" be expected to pass on successfully to the next generation the scientific spirit which is being stultified in himself.

In the course of my own graduate work I was given the advice which has doubtless been given to many another young man: "The thing for you to do now is to turn out as much research as you can in the next couple of years. A university in considering you for a position will not ask what you *can* do but what you *have* done."

We face a situation to-day in which many young men are admittedly "turning out all the research they can," with the frank purpose of getting themselves ahead, only secondarily—if at all—for the pure love of science. It is not a situation which can be easily remedied. Our universities are apparently "sold" on the idea of mass-production, at once the boon and the curse of our modern times. "Production" is the slogan of to-day, but we are beginning to question whether production, when bought at the expense of the bodies and souls of the producers, may not after all be a shortsighted policy. What is quite probable in the field of industry is a thousand times more than certain in our educational institutions. To be of most value to the world—yea, even to maintain its maximum *productivity*—the scientific mind in our universities must be "amateur."

NORRIS W. RAKESTRAW

STANFORD UNIVERSITY

DEAN INGE ON THE RELATION BETWEEN SCIENCE AND RELIGION TO-DAY

AMERICAN biologists have been none too active in resisting the attacks of the so-called "fundamentalists." The most that is usually claimed by them in their own defense is that there is no necessary hostility between science and religion. It is then all the

more refreshing to find no less a churchman than the Very Reverend W. R. Inge, Dean of St. Paul's, London, proclaiming his belief that "in science has come the chief revelation of the will and purposes of God that has been made to our generation." The following brief quotations will serve to indicate Dean Inge's position. They are taken from his article "The Social Message of the Modern Church" in the January *Yale Review*, in which article interested scientists will find much for reflection and inspiration.

I believe that in science has come the chief revelation of the will and purposes of God that has been made to our generation. I believe that it is more important for the Christian preacher to understand this new revelation, and to apply it to his ethical teaching, than to cultivate a sympathy with social revolution and the "demands" of manual labor. Perhaps the great struggle of the future will be between science and sentimentalism, and it is by no means certain that the right side will win. . . . There are many temptations to the churches to side with the anti-scientific forces. There has been and still is a conflict between traditional theology and natural science. . . . Science and philosophy (even religion) are willing to learn from each other, and a *rapprochement* is in sight. But the so-called fundamentalists, or traditionalists, still dream of routing the enemy, and are willing to use the most dubious allies for the purpose. It is, of course, they who are the real materialists, since they can not conceive of a religion which is not buttressed by miracle and special interventions. The more that our clergy can study the philosophy of religion, the better it will be for them and their hearers. We have to come to terms with the scientific view of the world. There is no reason why this old feud should be perpetual. Christ never wished to oblige us to outrage our scientific conscience as a condition of being His disciples. Our traditionalists bind heavy burdens, grievous to be borne, and lay them on men's shoulders, burdens which are no part of the burden of the Cross, no part of the light and easy yoke which Christ told us to take upon us, but which on the contrary are a terrible impediment to thousands who wish to be Christ's followers, but can not swear black to be white to please the authorities.

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I am afraid it is not so much any particular results as the whole scientific way of approaching questions, which is hateful to traditionalism. For this reason, I beg those of my readers who are religious teachers to try to keep an open mind, and at least to recognize that men of science are sincerely anxious to make their contribution to the problems of civilizations, that they have a strong case, and that their motives are as pure as your own.

* * * * * * * * *

I believe therefore that in so far as we connect the kingdom of God with the progress of the human race, we who are Christian ministers ought to give much more attention than we have hitherto done to the discoveries of modern science, and to the scientific way of looking at things. . . . I also hold very strongly that a reconciliation between religion, science and humanism is overdue.

Neil E. Stevens

Bureau of Plant Industry,
Washington, D. C.

SCIENTIFIC BOOKS

Climatic Laws: a summary of climate. By Stephen Sargent Visher, Ph.D., associate professor of geography, Indiana University. John Wiley & Sons, Inc., New York.

It is a thankless, perhaps even an ungracious, task to discuss adversely a book upon which the author has, as the reviewer knows, labored long and painstakingly. The intention was to provide a series of concisely worded generalizations, each followed by brief amplifying comments, the whole to constitute a body of fact which would "make it somewhat less difficult for students of climate to obtain an understanding of this important subject."

We are introduced first to twenty-five meteorological laws grouped under temperature, winds and moisture. The climatic laws, ninety in number, then follow in four chapters: on heating and cooling of the earth (laws 1–26), winds (27–50), moisture (51–80), and miscellaneous (81–90)—truly a large structure to try to erect in eighty-one pages. To say that in building it the need above all else is for severely logical thinking as the only means to clearness and accuracy is to utter a truism.

One reads but a few of the meteorological laws, however, before beginning to wonder if such thinking laid the foundation stones of the structure under review. On page 9:

3. The lower atmosphere is warmed chiefly by the absorption of terrestrial radiation and to a minor degree by the absorption of solar radiation.

4. The lower air is cooled chiefly by convection, *i.e.*, the rising of warm air, and subsequent radiation to cooler air and into space. It is sometimes [!] cooled by radiation to cooler land or water.

There are no comments to amplify the meteorological laws; hence the difficulty obviously is that it is impossible to express in any such simple terms as these the complicated interrelations of the processes by which the lower atmosphere is warmed and cooled. The result is a statement of half-truth, imparting, however, to the uninitiated the delightful sensation as of a "fact" acquired.

In summarizing (p. 10) the "laws of heating," a cycle of daily changes is presented, ending with: "Then gravity pulls it [the air] down to the earth's

surface where it awaits another warming the following day." The picture thus offered to the unsuspecting student is so simple—but, as meteorologists have long since recognized, so untrue.

On page 11: "Surface winds are influenced by topography and surface temperature. Winds tend to descend slopes, to follow valleys . . ." The implication of the words as printed surely is that winds do not tend to ascend slopes—an astonishing comment, for example, on the often violent effects of day-time up-slope winds among mountains. The reviewer feels certain that the writer never intended that implication, but clear thinking would have kept such a statement out of print. And one wonders why a publisher should so far fail in the matter of self-protection as not to catch the vacuity of the following (law 81): "Air pressure decreases with increased elevation because the atmosphere envelops the rest of the earth."

"82. There are seasonal and diurnal variations in air pressure related to changes in temperature *but with the opposite sign, falling as the temperature rises.*" (Reviewer's italics.) Now the average elementary student, unwitting victim of mass production in "education," dearly loves to regard his textbook as infallible. At any rate, acting on that assumption helps him to "pass" courses. Therefore it is too much to expect him to wonder whether the spectre of vagueness and half-truth lurks in a statement like the above. The fact is that the diurnal temperature and pressure changes do normally show approximately opposite trends for stations at and near sea level, but that quite the reverse is true for high-altitude stations. It is precisely in this fashion that the spectre bobs up constantly through large sections of the book.

The purpose of the author being to discuss *laws,* it seems unfortunate that he should occasionally (*e.g.,* pp. 25–26) indulge in speculation based too often upon the hypothesis that if such-and-such were the case, the results would be so-and-so. It may be seriously questioned whether it is wise, in a book of this nature, to enter into highly debatable ground—a procedure which can only confound the student for whom evidently the volume is intended.

The bibliographic notes are abundant, and, if used with discretion, will serve a purpose. One becomes skeptical of the author's judgment, however, upon finding that some of the notes refer to text-books (at best second-hand "sources") that are more or less seriously out of date meteorologically. Moreover, one fails occasionally to find references in critical places to the leaders in the particular fields. Thus under "sensible temperature" there is no mention of Leonard Hill, under "cyclones of mid-latitudes" no mention of Bjerknes. Indeed, nothing indicates that the author considers the great conceptions relative to surfaces of discontinuity, warm and cold fronts, etc., to be of any importance to the student of climate who would attempt to keep pace with the development of modern thought in these matters.

Lest the above comments seem too pessimistic, it should be made clear that although the reviewer believes the book *as it stands* could only prove to be an educational pitfall, not alone to the elementary student but to an unwary teacher, nevertheless he also believes that those possessing a sound background of training in meteorology and climatology could find use for the volume. Thus, there is in it abundant statistical and bibliographic material which the teacher of, let us say, geography, could, *if so trained,* use to advantage. But he should, in order to decide whether he is thus trained, first inquire if his knowledge is based upon something more than the outworn conceptions of meteorological processes to be found in the average American "college" text. Then, if he can qualify, and has both time and inclination for the task, let him proceed to select and rearrange from "Climatic Laws" such materials as meet his particular needs.

BURTON M. VARNEY
WASHINGTON, D. C.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPLICATION OF THE MICROSCOPE TO GALVANOMETRY

THE intention of this note is to draw attention to the possibilities of the microscope as an aid in galvanometer observation. When a galvanometer is used as a null indicator in potentiometer or Wheatstone bridge work the sensitivity of the instrument should be high enough to give an unmistakable change in the galvanometer reading when the slide wire contact is altered by the smallest readable amount. In operations with galvanometers of the portable pointer type it sometimes happens that this condition does not obtain, and it then becomes necessary to turn to the reflection galvanometer, with its more troublesome technique, or to find means of extending the divisions-per-volt sensitivity of the pointer instrument. The latter recourse is to be preferred and is easily affected by bringing a microscope with a power of perhaps a hundred diameters to focus on the tip of the pointer. The eyepiece should be furnished with a scale. It is easy by these means to obtain an increase in apparent sensitivity of sixty to one hundred fold.

The quickness, steadiness and convenience of this

arrangement recommend it for use in place of the reflection galvanometer, not only for null indications but also in many cases of current and voltage measurement. Sensitivities of a like order with the more modest wall-type instruments are readily attained.

The very highest sensitivities are to be obtained of course with reflection galvanometers, and here too the microscope may be employed to extend the range of the instrument to much smaller currents and voltages than those ordinarily observed. Light from a vertical lamp filament, passing through a convergent lens, falls upon the galvanometer mirror and comes to focus before the objective of a horizontal comparator microscope instead of upon the customary scale. The observer uses the comparator in the usual way, setting the cross-hair or index upon the edge of the filament image and taking readings at the micrometer head.

On an ordinary scale one would perhaps be able to detect an image shift of one fifth of a millimeter. With a comparator suitably arranged a displacement one one hundredth as large is definitely observable. In a recent test a filament of a 40 watt tungsten lamp was used as source, while a lens of 60 cm focal length produced the image. The mirror was of good quality, plane and circular, and had a diameter of 1.1 cm. At a distance of 200 cm from the mirror a comparator with a magnification of thirty diameters was located. The definition of the image was greatly improved by the insertion of a green Wallace filter at the comparator objective. With the mirror in a fixed position the comparator index was set upon the edge of the image ten times and the micrometer head readings recorded. The average deviation of these readings from their mean was .0001 cm, which shows that any rotation of the mirror, so long as the image remained within the range of the comparator, could by a single setting be measured with a probable error of 1/20 second of arc.

With the galvanometer before me at present—a style to be found in most university physical laboratories and one without claims to high sensitivity—these figures suggest the possibility of measuring currents of the order of 10^{-11} amperes. Unfortunately, however, the perturbations to which these types are subject prevent making full use of this unusual magnification.

The angular sensitivity described is due in part to the use of the comparator screw, by which the observer is relieved of the task of estimating the precise position of the image with respect to a series of scale rulings. It is well not to forget that this objectionable operation, which limits the accuracy of scale measurements of all kinds, may generally be avoided, if the ends justify the effort, through mechanical devices such as we have considered here. The ordinary vernier supplies the simplest and best illustration.

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SPECIAL ARTICLES

AN HYPOTHESIS ON CELL STRUCTURE AND CELL MOVEMENTS BASED ON THERMODYNAMICAL CONSIDERATIONS[1]

ALL living matter is principally built up of aqueous solutions of substances which have the property of lowering substantially the surface tension of water. It is known that these substances will tend to reach an equilibrium by accumulating at interfaces. This is just a consequence of the application of a well-known thermodynamical law: a system always tends towards a state of equilibrium where the free energy will be the minimum compatible with its total energy. If a droplet of such a solution is abandoned in a small hollow in a rock, or sprayed into the air, under any circumstances where it will be momentarily separated from the bulk, its constituents in solution will concentrate in the surfaces, the solubility of some of them, in case of a complex solution, will be affected by the presence of salts and of CO_2, coagulation will follow, and it will be surrounded by a membrane. On the other hand, since the works of Gibbs and Boltzmann, we know that the state of equilibrium predicted by thermodynamics for any material system is always "the most probable state compatible with its total energy, potential and kinetic." Hence, we may say that "the most probable equilibrium configuration of such a system is the cell form," which is equivalent to saying that the state of thermodynamic equilibrium of a system composed of proteins[2] in solution with salts, under the conditions stated above, is the cell form. However, the size of the original droplet is not indifferent, and the foregoing observations, based on experimental evidence[3] and theoretical considerations, are only likely to be applicable in the case of droplets small enough to coat themselves with an adsorbed layer of protein of sufficient thickness in a very short time. The smaller the droplet, the more rapidly its surface layer will be saturated with protein.

[1] From the Laboratories of The Rockefeller Institute for Medical Research.

[2] Or any other organic substance of high molecular complexity endowed with the same properties with regard to surface tension. The term "protein" is used throughout this paper for the sake of brevity, but the experimental facts and the hypothesis may apply as well to other compounds found in the cells and in the plasma, for instance, or to a combination of them.

[3] du Noüy, P. L., *J. Exp. Med.*, 1922, xxxv, 575, 707; SCIENCE, 1924, lix, 580.

It has been shown that the static value of surface tension in pure serum, for instance, is reached in about twenty minutes in watch-glasses, where the depth of the liquid is about 3 mm, and consequently the longest vertical path traveled by molecules is 1.5 mm. In the case of a spherical droplet of the same diameter (3 mm), it would require about the same time to reach the equilibrium, that is to say, to coat it with a layer of concentrated protein. But the same phenomenon would require only about 1 second if the droplet had a diameter a thousand times less, namely 3μ. In a finely atomized spray of, say, a 6 per cent. solution of proteins, a large number of droplets would consequently, under certain circumstances (ultra-violet rays, CO_2 atmosphere, HCl gas, etc.), be readily transformed into a cell with a membrane three hundred to four hundred times more viscous[4] than the inside liquid, and partially insoluble in water. According to the time that elapses between the spraying and the moment the droplet strikes water again, cells of different sizes may be formed. Thus, the initial order of magnitude of these cells is determined somewhat by the concentration of the solution and the time defined above.

Furthermore, it has been shown that protein solutions, under certain conditions of concentration, volume and surface, could organize monomolecular layers, or monolayers, at the interfaces. This was first proven experimentally in 1924.[5] The curves expressing the static values of surface tension of such solutions, drawn in function of the concentration, showed marked minima at certain critical concentrations. These minima, being due to a static arrangement of oriented, fixed molecules, can not be accounted for on a thermodynamical basis. The Gibbs formula may enable us to calculate the static value of an egg albumin solution at a concentration of 1/138,000 and at a concentration of 1/142,000, but these points are on a smooth curve, and if, as happens, a minimum occurs between these two points, due to organization of molecules, no thermodynamic formula as yet can foresee this fact, which depends on the size and shape of the individual molecule. Thus, one may expect a sudden change in the surface tension at the interface between air and solution, or between two solutions, not necessarily as a consequence of a chemical reaction, as has always been assumed so far, but also as a consequence of a very slight change in the concentration of either the outside or the inside liquid, according to whether one considers the inside adsorbed layer or the outside adsorbed layer. A relative change in the concentration of the order of 2/100 (from 1/138,000 to 1/140,000, for instance) may bring forth a decrease of surface tension of a few dynes (three to eight in the case of egg albumin—air interface), on a limited area of the cell, if this change in concentration only affects part of the surrounding liquid. This area will, of course, immediately bulge out under the influence of the internal pressure. Changes in concentration of such order of magnitude should be expected to go on almost constantly, as a consequence of the fluctuations of density, under the influence of the slightest cause: foreign bodies adsorbing protein molecules, particles going into solution, etc.). Therefore, the changes in surface tension may be considered as occurring constantly. The time required to organize such a layer over a limited area of a cell must be very small, if the concentration of the solution inside the cell is such as to make the formation of a monolayer possible. Indeed, the aforesaid hypothesis requires one condition, namely, that the concentration and the size of the cell be related in a certain way. In our experiments (watch-glasses), monolayers were produced at dilutions around 1/140,000 and 1/190,000 for egg albumin and around 1/10,500 for serum. In these experiments, the ratio $\frac{\text{surface,}}{\text{volume}}$ which evidently determines for every concentration the possibility of forming the monolayer, was equal to 13.2 approximately.[6] It is clear that in order to obtain a monolayer formation with pure serum, for instance, it would be necessary to use a much smaller vessel, so that the ratio $\frac{\text{surface}}{\text{volume}}$ would be increased 10,500 times, namely, up to 137,000. Such an enormous ratio can exist only in a very small vessel, or a vessel whose shape is that of a flat disk. A simple calculation shows that it should have such inside dimensions as, for instance, 5μ in diameter and 0.2μ in thickness, in which case the ratio $\frac{S}{V} = 150{,}000$. Under such conditions, the formation of a monolayer is possible from the inside, with a concentration of proteins corresponding to that of pure serum. This calculation assumes, of course, that this cell contains no nucleus or bodies capable of adsorbing the protein (mitochondria). In the latter case, the size of the cell could be larger without a concurrent decrease in the ratio. Should this ratio

[4] du Noüy, P. L., Science, 1925, lxi, 117.

[5] du Noüy, P. L., *J. Exp. Med.*, 1924, xxxix, 37; xl, 133.

[6] It has been shown experimentally (footnote 3, and Third Colloid Symposium Monograph, 1925) that the concentrations at which the monolayers were observed, in the case of protein solutions, depended on the ratio $\frac{S}{V}$ of the container, and were proportional to the value of this ratio. This fact was recently confirmed in the case of sodium oleate (unpublished experiments).

decrease, then a more dilute solution would be required to build up the monolayer; should it increase by flattening of the cell or change in its shape, or should adsorbing bodies be formed inside the cell, a more concentrated solution would be necessary to build it. And reciprocally, if it be assumed that the size of the cell is determined somewhat by the possibility of forming, under certain conditions, oriented monolayers of proteins, the slightest change in the concentration, as might be brought about by changes in the pH which affect the solubility of these substances, will determine a change in the ratio $\frac{S}{V}$, and the cell will grow or diminish in size, or alter its shape. Consequently, the normal concentration of biological fluids might be one of the factors determining the size of the living cells. Should our hypothesis be true, they could not exist outside of a certain range of dimensions, and their activity would depend, among other factors, on how near the critical concentration they may be with respect to their ratio $\frac{S}{V}$; indeed, if these three quantities happen to be balanced in such a way as to make the building of monolayers possible, they will be in a constant state of activity, as anything affecting the concentration will change the surface tension, while in turn any phenomenon affecting the surface tension on one point will determine a variation in the ratio $\frac{S}{V}$, which will result in a fluctuation in density in some other part of the cell, with a corresponding change in surface tension.[7] In certain cases, where the externally adsorbed layer seems to be of constant thickness (red cells), the solid oriented layer of adsorbed serum proteins gives a certain rigidity to the cell. This adsorbed layer, the order of magnitude of which is about 40 Ångstroms (40×10^{-8} cm), is probably fixed on an inside layer, the thickness of which can not be computed. Thus the ratio $\frac{S}{V}$ of the inside of the cell may be larger than the outside ratio and correspond to a higher concentration of proteins, not to mention the possibility of inside adsorbing elements.

It is needless to say that the preceding hypothesis is given only tentatively and that the writer does not wish to lay any emphasis on it. However, considering the somewhat striking coincidence of the figures, and the interesting departure from thermodynamic equilibria realized by the formation of oriented layers, it is possible to conceive that phenomena of a similar nature play a part in the still mysterious behavior of cells. It throws no light, however, on the inside structural elements of the cell, and the nucleus, for example, remains unexplained.

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[7] It is usually admitted that the cell content is rather a concentrated solution of proteins. If this is true it becomes necessary to suppose that there is a considerable surface of adsorption inside the cell, in addition to those which can be seen under the microscope.

A NEW AREA OF CARBONIFEROUS ROCKS IN MEXICO

THE locality which furnished the material for this notice was discovered by Mr. Parker A. Robertson, a geologist of the Mexican Gulf Oil Company. He made a small collection at the original locality and later, with Mr. J. M. Muir, a geologist of "La Corona" Compania Mexicana, he made a larger one at a nearby point. The material thus obtained was sent to Dr. L. W. Stephenson, and he, recognizing that the fauna was Carboniferous in age and consequently of less interest to himself than to me, obligingly placed it in my hands for examination. This note is published by the kind permission of the authorities of the Mexican Gulf Oil Company.

The fossil locality is in Peregrina Canyon, eleven kilometers west twenty-two degrees north of Victoria in eastern Mexico, and is remote by at least five hundred miles from any authentic area where Paleozoic rocks have as yet been reported. A possible exception is an unconfirmed occurrence of undivided Carboniferous rocks in the San Carlos Mountains about seventy miles northeast of Peregrina Canyon.[1] This discovery of Mr. Robertson's is of considerable interest, on this score alone, but in addition the fauna is of an age and facies quite unexpected. Had it proved to be Permian or Pennsylvanian, the discovery would have been interesting but not surprising, but the fauna proves to be early Mississippian and of a type less comparable to the contemporaneous faunas of our border states such as the Lake Valley limestone or the Escabrosa limestone, than to faunas of Missouri or of Ohio.

The most characteristic features of the fauna from Peregrina Canyon may be set down here, although a more searching description will be given in another place. The most abundant fossils, probably, belong in the genus *Syringothyris,* and represent three types more or less closely related to species in the lower Mississippian of Iowa and Missouri. A large *Reticularia* scarcely distinguishable from *R. pseudolineata* is also abundant, and *Athyris lamellosa,* though more rare, is highly distinctive. *Spiriferina, Delthyris* and *Chonetes* are present as well, but *Productus* appears to be rare. It is, however, represented by a large species of the semireticulate type, closely resembling a common member of the Waverly fauna of Sciotoville, Ohio. Altogether, the faunal aspect is clearly early Mississippian and probably equivalent in time value to the Burlington and Keokuk of our Mississippian section.

[1] See geologic map of North America, 1911.

The limestone in which the fossils occur has been brought to the surface by a pronounced structural uplift, and reveals the following succession of rocks:

Section in Peregrina Canyon
(By Parker A. Robertson)

	Approximate thickness *Feet*
Cretaceous:	
Medium to heavy bedded limestone	2000
Unconformity (?).	
Cretaceous or Jurassic:	
Medium bedded light gray limestone above, heavy bedded dark gray limestone below	300
Basal conglomerate containing fragments of the underlying red sandstone and quartz pebbles	50
Great unconformity.	
Triassic or Permian:	
Fine-grained rather soft red sandstone	200
Medium bedded red shale, arenaceous in parts	485
Basal conglomerate with fragments of underlying sandstone and quartz pebbles	15
Unconformity.	
Lower Mississippian:	
Medium to heavy bedded dense quartzitic, calcareous sandstone	350
Hard dark shale, containing *fossils of lower Mississippian age*	50
Medium bedded dark gray to black carbonaceous shale interbedded with thin beds of sandstone	750
Unconformity.	
Probably pre-Cambrian:	
Schist, probably metamorphosed sediments	1000
Unconformity (?).	
Heavy bedded rather fine-grained light colored gneiss	1500

GEORGE H. GIRTY

GEOLOGICAL SURVEY,
WASHINGTON, D. C.

THE ASSOCIATION OF AMERICAN GEOGRAPHERS

THE Association of American Geographers held its twenty-second annual meeting at the University of Wisconsin, December 30, 31 and January 1, under the presidency of Professor R. H. Whitbeck. The meeting included six half-day sessions, an evening round table and the annual presidential dinner. Special half-day sessions were devoted, respectively, to "The Caribbean Region," "Field Geography" and "Urban Geography." The papers presented were, on the whole, of high quality. Most of them, in their careful attention to areal and quantitative detail, indicate gratifying progress in method and technique of geographical investigation. The introduced papers clearly demonstrate that scholarly work is being done by the younger group of geographers. The plan adopted of scheduling time for discussion after each paper resulted in vigorous and illuminating discussion, and yet allowed the entire program to go forward on schedule. All the regular sessions were held in Science Hall, and the association is greatly indebted to the Department of Geology and Geography and to the officials of the university for their fine hospitality. For luncheons and the annual dinner the association enjoyed the facilities of the University Club. The feature of the dinner was a scholarly address by President R. H. Whitbeck on the subject of "Adjustments to Environment in South America: an Interplay of Influences."

As an inventory of American geography, this program demonstrated that geographic research of high order is under way at a number of institutions where separate departments have been established recently, or where the subject relatively recently has been introduced under the auspices of some other department. Thus, from the geography department at the University of Michigan, K. C. McMurry gave the results of "A Study in the Use of Soil Types in Geographic Mapping," and Preston E. James read "A Geographical Reconnaissance of Trinidad." From the new department at the University of Minnesota D. H. Davis outlined the "Objectives in a Geographic Field Study of a Community," and Richard Hartshorne presented the "Factors in the Localization of the Iron and Steel Industry." C. C. Huntington, of the department of geography at Ohio State University, discussed "The Main Divisions in the Classification of Geography." From the geographic wing of the department of geology at the University of Illinois, W. O. Blanchard presented "The Landes—a Problem in Conservation," and John B. Appleton summarized the findings of a monograph on "The Calumet Steel District." Lewis F. Thomas, of the department of geology and geography at Washington University, discussed "The Localization of the Wholesale and Jobbing Industries in Metropolitan St. Louis," and Mary J. Lanier, of Wellesley College, in a paper on "The Early Development of Boston as a Commercial Center," presented a notable contribution in the field of historical geography.

That rapid progress is being made in the technique of geographic mapping and in the use of quantitative data in the solution of geographic problems was disclosed by the special session on field geography. Under the title previously mentioned D. H. Davis stated the objectives of a survey for an agricultural community and emphasized the importance of such objectives in orienting the study. Derwent S. Whittlesey, of the University of Chicago, discussed the re-

sults of "An Experiment in mapping a Small Section of the Door Peninsula, Wisconsin, for Use in Geographic Study." K. C. McMurry reported the progress being made in his experiments at the University of Michigan, looking towards the determination of the place occupied by soil in the environmental complex, and also showed how the more recent work of the United States Bureau of Soils and allied bureaus may be adapted to geographic use.

A highly successful special session on urban geography betrays a rising tide of geographic interest in urban problems. V. C. Finch, of the University of Wisconsin, set the pace for this session in an illuminating study of "Culture and Landscape at Madison, Wisconsin." This presentation of an important aspect of the geography of the place of meeting established a precedent which may be followed with profit at future meetings. Three papers dealt with the geographical aspects of the iron and steel industries. Richard Hartshorne challenged the adage "Iron moves to coal," and showed that this generalization may or may not be true according to the alignment of the other factors involved. The geographic relationships of significance in the development of iron and steel industries were illustrated for a relatively new area by John B. Appleton in his study of the "Calumet Steel District" and for one of the oldest districts by John W. Frey, of the University of Wisconsin, in a paper entitled "The Iron and Steel Industry of the Middlesboro District, England." Frank E. Williams, of the University of Pennsylvania, reported significant progress in a distinctly original study of the "Philadelphia Suburban Industrial Development." He has mapped the distribution of factories in Delaware County at several periods and has traced varying products of typical establishments during the course of the hundred years or more of their existence. The geographic quality of a partciular site within a metropolitan district was illustrated in the paper read by Lewis F. Thomas. He showed why the wholesale and jobbing industries in St. Louis have occupied the same site throughout the vicissitudes of transportation in that city. Howard H. Martin, of the University of Cincinnati, reported on the "Geographic Phases of the Cincinnati Resource Survey." This survey is being made by the University of Cincinnati at the request of a group of business men of the city. It is under the immediate direction of Nevin M. Fenneman, who is employing the augmented staff of the department of geology and geography for the purpose.

That existing railway lines in Central America do not cross political boundaries, that there are no connecting lines which might serve as links in the oft-proposed Pan-American route, and that the railway pattern is closely related to relief and local resources was brought out by Robert S. Platt in his study of "Central American Railways and the Pan-American Route." Another significant study of railway transportation was that by Raus M. Hanson on "Geographic Factors in Railroad Revenues of Nebraska." Continued interest among geographers in the problems of land utilization was evidenced in a number of papers. O. E. Baker, of the Bureau of Agricultural Economics, in a notable study of the "Shifts in Land Utilization as shown by the 1925 Agricultural Census" treated in a graphic way one of the more urgent of our national problems. He analyzed the factors which have accelerated the shift of rural population to urban districts in some sections of the country and those retarding it in other sections. He also suggested how such shifts in population reflect the degree of prosperity in the farming communities. W. O. Blanchard, in his study of the Landes previously mentioned, showed how an almost destitute section of France has been rejuvenated by a constructive land utilization program. Wallace W. Atwood reported the continuation of his studies in the San Juan Mountains in a paper entitled "Settlement and Economic Development in the San Juan Region of Colorado."

Noteworthy papers which do not come under the foregoing classifications were "Trade Routes used by American Trade," by Helen M. Strong, of the Bureau of Foreign and Domestic Commerce; and "The History of Geography: a Point of View," by John W. Wright, of the American Geographical Society. At its last session the association was highly honored by an address on "Geographic Sectionalism in American History," by one of its members of long standing, Frederick J. Turner. Professor Turner showed that, in the attitude towards and in the votes upon national problems, the states in many instances have lined up in regional groups rather than as individual units.

The meeting in 1926 will be held at the University of Pennsylvania on December 28, 29 and 30. The officers for 1926 are: *President,* J. Paul Goode, University of Chicago; *vice-president,* George B. Roorbach, Harvard University; *secretary,* Chas. C. Colby, University of Chicago; *treasurer,* V. C. Finch, University of Wisconsin; *editor,* Almon E. Parkins, George Peabody College for Teachers; *councillors,* Wellington D. Jones (University of Chicago), Oliver E. Baker (U. S. Bureau of Agricultural Economics and Clark University), Philip S. Smith (U. S. Geological Survey), Curtis F. Marbut (U. S. Bureau of Soils) and R. H. Whitbeck (University of Wisconsin).

CHAS. C. COLBY,
Secretary.

UNIVERSITY OF CHICAGO